# TRAFFIC QUARTERLY

AN INDEPENDENT JOURNAL FOR BETTER TRAFFIC

OCTOBER 1954

National Highway System
Ground Facilities at Airports
An Appraisal of Shopping Centers
Sacramento's Off-Street Parking Program
Miami Surveys Show Stable O-D Pattern
Regional Studies for Business Men
Highway Sufficiency Rating Study
Use of Radar in Speed Control
Everyday Traffic Engineering
Neighborhoods and Traffic
Snow Emergency Program
Indiana's Toll Roads

THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL

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# Traffic Quarterly

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# For a National Highway System

OUR highway traffic has reached a point of great concern to the public. To everyone it is of the utmost importance in pleasure, in work and in living.

It is universally discussed but despairingly accepted. These discussions clearly indicate the public's contention and point of view that we need a planned national master highway system in the efficient and further development of our economic welfare.

In any consideration of our present and predicted road needs, the states and federal government are burdened with a colossal financial problem constantly increasing and of long duration. It is doubtful if sufficient thought, statistical knowledge, and exploration have been accomplished to assure the expenditure of the necessary funds wisely and profitably.

Emphasis on our present effort toward a solution of the problem is made through local, sectional and private interest without much thought of its fitness in the national problem or the general public good.

The development of areas bordering first-class thruways demonstrates the importance of this phase of road building. It implies the need for continental thinking.

Final decisions in our present trend toward toll road construction rest largely on the projects' revenue potential. Serious national requirements receive secondary consideration only where chances for financial success are manifestly favorable or overwhelming.

In our needed expansion of more and better roads, it is folly to rely heavily on private financial interests. Future conditions for financial success will be less favorable and predictions less reliable as we reach the fringe of densely inhabited areas.

The present toll-road building activities of New England, New York and New Jersey, extending west to Indiana, afford an excellent example of coverage of a large and important section of the country. They follow approximately the proposals of the National Interregional Highway Committee pertaining to New England, Mid-Atlantic and East North Central regions.

Both their combined approximate cost and effect will be im-

pressive. In comparison, their initial cost may well be a minor consideration in the economic wealth they create. Unfortunately they were planned by force of circumstance, not concurrently and not as a part of a greater whole. The Interregional Committee was born of foreseeable economic conditions consequent upon the termination of World War II.

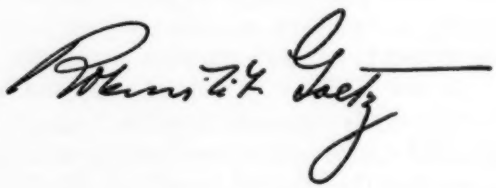
Our present spurt of building master roadways has been influenced by inter-city traffic between overcrowded population centers, reasonable assurance of financial success, and intolerable traffic congestion. The program only partly fills the urgent need for better national highway communications and terminal facilities. Many city problems are aggravated by present efforts.

Since World War II our national requirements have increased and changed. Our national progress should be encouraged by suitable national highways as life-lines to partly developed and idle areas. To assure our country's progress, its defense, its economic and industrial expansion, our road program should encourage trends toward an advantageous distribution of our growing population.

We must have a Master Road Plan based on mature study, present conditions, desirable changes and predicted future needs.

It should evolve under federal leadership with the full participation of state authorities, free of all interference in state programs, and provide incentive for state adherence.

Roads should lead, not follow, the people.



# Planning Ground Transportation Facilities for New Airport

LOUIS E. BENDER

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IN 1947 the Port of New York Authority assumed responsibility for operation and development of the two New York airports—New York International Airport and La Guardia Airport—under a fifty-year lease agreement with the City of New York.

Construction of New York International Airport was begun by the City in 1942. Opened by the Port Authority in 1948, the airport climbed to tenth place in the nation in air-carrier movements by the end of 1952. Approximately two and a half million passengers and about 90,000,000 pounds of air cargo were handled at the airport during 1953. The United States aerial gateway to the world, New York International handles most overseas flights in the New York-New Jersey metropolitan area and about 20 percent of the domestic passenger traffic.

A great eleven-story, million-dollar control tower was built by the Port Authority and opened in 1952. The Port Authority also has constructed the airport's other major buildings, including the three largest triple-hinge steel arch hangars in the world and a three-million-dollar, six-bay hangar completed in 1953. Other major hangar building developments are under construction or planned. New York International Airport is as large as all of Manhattan

Island from 49th Street to the Battery and its seven 200-foot-wide runways have a total length of almost ten miles.

La Guardia Airport, one of the busiest air terminals in the world, handled more than 13,000 passengers, 105,000 pounds of mail, and 290,000 pounds of air cargo daily during 1953. On an average, a plane lands or takes off from this airport every three minutes. Close to midtown Manhattan, La Guardia Airport is especially well qualified to fill its future role as a terminal for short and medium length air trips.

During 1951 all overseas operations at La Guardia Airport were transferred to New York International Airport, making available valuable terminal facilities in the overseas area at La Guardia Airport. This area has now been developed for non-scheduled air-carrier operations and for the expanding activities of private executive corporate type of aircraft.

At La Guardia's famed observation deck, the Port Authority operates a public address system on weekends, and holiday afternoons in the spring, summer and fall, giving an interesting description of activities at the airport. Guided tours offer visitors the opportunity of going behind the scenes to see the airport in operation. More than 7,800 persons are employed at La Guardia.

Newark Airport, operated by the Port Authority since 1948 under a similar fifty-year lease with the City of Newark, is closest of the metropolitan airports in point of time to the west side of Manhattan as well as to the New Jersey residential and industrial region. It is being developed as one of the leading air terminals in the nation.

A modern passenger terminal building, about five times the size of the former outmoded and inadequate administration building, was constructed at a cost of $8,500,000 and opened in the summer of 1953. The terminal contains the world's largest glass enclosed observation deck, 500 feet long on the mezzanine.

Newark Airport will handle about half of the transcontinental passenger flights, a small percentage of the short-haul flights, and a majority of the cargo flights entering or leaving the Port District. It is expected that Newark Airport which handled over a million passengers in 1951 will handle over 5.4 million in 1980. About 2,500 employees now earn $12,000,000 annually at this airport.

## Accessibility Is Prime Requisite

One of the first requisites in a well-planned airport is to locate it where it is accessible to those who will desire to use it. This means it should be connected to a well-planned road network and accessible to mass transportation facilities. These three principal airports in the New York metropolitan area have or will have connecting links which will make all of these airports readily accessible to any district throughout the port area.

The proposed regional highway development program in the Port District during the next decade as shown in Figure 1 will consist of new parkways and expressways which will provide airport users with easier access to the Port Authority airports.

FIGURE 1

La Guardia Airport, now conveniently served by access roads leading from Grand Central Parkway, will be further aided by the Brooklyn-Queens Expressway now under construction. It will extend from Gowanus Parkway in Brooklyn and connect with Grand Central Parkway at a point a short distance east of the Triborough Bridge. This development will provide residents of Brooklyn with direct access to La Guardia Airport.

To accommodate the traffic from upper Manhattan, Bronx and Westchester, the Major Deegan Expressway, the Cross-Bronx Expressway and the Bronx River Expressway will, upon completion, combine to facilitate the movement of airport users to either La Guardia or International Airports.

The Van Wyck Expressway is a connecting link with Grand Central Parkway and further expedites traffic from Manhattan and parts of Brooklyn and Queens to New York International Airport.

The New Jersey Turnpike, together with the additional improvement of major highways in New Jersey, provides New Jersey residents direct access to Newark Airport. The expressways in New York, when completed, will also help to expedite movement of air travelers originating in Manhattan to Newark Airport.

### Transportation Studies Provide Data

To provide the proper service and facilities at an airport for ground transportation an analysis must be made of the modes of transportation carrying employees, visitors, sightseers and air passengers.

When the Port Authority first took over these airports seven years ago, little data existed on the modes of transportation and the extent to which each served the airport. Measuring sticks, to determine properly the size of facilities necessary to accommodate various modes of transportation, were not available. In most metropolitan airports it was found that after the airport was completed almost every facility, and particularly terminals for ground transportation units, were inadequate shortly after opening. This was true in the New York area.

In 1949 our aviation department started making studies to determine how to measure the facilities that would be required in further expansion of existing airports and the planning of future ones. Data

have been gathered for the last three or four years to measure modes of transportation, thereby providing the necessary measuring sticks for planning. These various modes of local transportation differed as to type, location, and quantity of space and facilities required at the airports to handle various levels of airport activity. Planning airport terminal areas, therefore, required a study of distribution of airport population volumes among the several types of local transportation services and also a more detailed consideration of the future development of these individual services.

The principal modes of transportation serving these airports are:

1. Private passenger cars.
2. Public bus service.
3. Taxi.
4. Airline coach.

Table 1 gives an overall picture of the distribution of air passengers by mode of ground transportation used. It can be readily seen that there is some variance in the modes of transportation to the

Table 1

PORT AUTHORITY AIRPORTS

PERCENTAGE DISTRIBUTION OF AIR PASSENGERS BY MODE OF GROUND TRANSPORTATION USED

COMBINED TWO-WAY MOVEMENTS

1949–1952

| | La Guardia | | | | | New York International | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Airport Coach | Taxi | Parking | Other | Total | Airport Coach | Taxi | Parking | Other | Total |
| 1949 | 32.9% | 27.3% | 20.5% | 19.3% | 100% | 58.4% | 14.0% | 49.3% | — | — |
| 1950 | 29.9 | 26.0 | 21.3 | 22.8 | 100 | 53.6 | 14.6 | 41.0 | — | — |
| 1951 | 27.1 | 23.8 | 18.6 | 30.5 | 100 | 42.2 | 12.4 | 43.3 | 2.1 | 100 |
| 1952 | 28.6 | 24.8 | 15.7 | 30.9 | 100 | 41.0 | 11.8 | 23.7 | 23.5 | 100 |
| Average | 29.6% | 25.5% | 19.0% | 25.9% | 100% | 48.8% | 13.2% | 39.3% | — | — |

| | Newark | | | | | Region | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Airport Coach | Taxi | Parking | Other | Total | Airport Coach | Taxi | Parking | Other | Total |
| 1949 | 66.1% | 13.0% | 15.9% | 5.0% | 100% | 40.1% | 21.5% | 21.2% | 17.2% | 100% |
| 1950 | 66.9 | 13.0 | 17.2 | 2.9 | 100 | 38.9 | 20.6 | 22.1 | 18.4 | 100 |
| 1951 | 57.4 | 11.2 | 18.7 | 12.7 | 100 | 34.9 | 18.0 | 21.6 | 25.5 | 100 |
| 1952 | 53.0 | 13.8 | 24.5 | 8.7 | 100 | 33.9 | 18.2 | 18.9 | 29.0 | 100 |
| Average | 60.8% | 12.8% | 19.1% | 7.3% | 100% | 37.0% | 19.6% | 21.0% | 22.4% | 100% |

various airports. This is because of their location and the facilities such as highways serving the airports. Another contributing factor in the mode of transportation is the availability of mass transportation. Newark Airport passengers are carried predominantly by airport coach. Classification "other" in Table 1 gives an individual total which includes transfer passengers who use no ground transportation, passengers driven to and from the airports in cars which do not use the parking lots, passengers traveling by city bus, and other minor groups.

At the New York airports the mass transportation system is not convenient and does not get its proper use. An unusually high proportion of air passengers is shown as using cars at New York International Airport during the period from 1949 to 1951. During these two years spectator volumes were high, so that a larger than normal number of parked cars were in no way associated with air passengers. From the standpoint of future air passenger ground use, 1952 is regarded as a more normal year at New York International Airport.

The best available indication of transportation means used by other components of airport population is reflected in the airport population survey. The survey count of arriving and departing passengers and vehicles on an average peak day, can be reconciled to provide a reasonable estimate of transportation methods used by the airport population. An estimate of ground transportation used at La Guardia on July 18, 1952, is shown in Table 2. An analysis of

Table 2

PERCENT DISTRIBUTION OF AIRPORT POPULATION BY MODE OF TRANSPORTATION

La Guardia Airport—Domestic Terminal

Average Peak Day—1952

| | Friday (July 18) | | |
|---|---|---|---|
| | Inbound | Outbound | Average |
| Cars | 64 | 67 | 66 |
| Taxis | 13 | 11 | 12 |
| Airport Coach | 9 | 7 | 8 |
| City Bus | 9 | 9 | 9 |
| Other | 5 | 6 | 5 |
| Population | 100 | 100 | 100 |

the average peak day, Friday, at La Guardia determined the means of transportation used by the various components of airport population such as spectators, employees and casual visitors. The modes of transportation employed by these airport users at La Guardia are contained in Table 3.

About 79 percent of the spectators on the observation deck arrive or depart by private car and only 12 percent use, in about equal proportions, taxi, airline coach and city bus. The remaining 9 percent are transfer air passengers who do not leave the airport. Over 60 percent of the employees arrive or depart by private car and about 35 percent use the city bus for transportation. More than 95 percent of the casual visitors at the airport come by private car. Only 5 percent depend upon public transportation.

Table 4 presents the modes of ground transportation resorted to by other components of air population at New York International Airport. Because of its location a larger proportion of the total airport population at New York International travels by car, including 76 percent of the spectators, 73 percent of the employees and 100 percent of the casual visitors. City bus is used by 6.8 percent of the spectators and 23.4 percent of the employees.

### Major Car Use Requires Parking Lots

It can be seen from these charts that public bus service does not as yet comprise an important part of the transportation used at airports. It is expected, however, that this mode of transportation will become increasingly important as air coach travel becomes more popular, and more direct and frequent service is provided. Surveys run by the Port Authority indicate such a change in this mode of transportation.

The most important component of traffic composition and mode of transportation is the private passenger car. Recognizing the importance of the passenger car terminal and its impact on the entire design of an airport, the Port Authority deemed it advisable to make a detailed study of existing facilities to determine their degree of adequacy and also provide data for future planning.

In August, 1953 our aviation department ran a survey of parking lot patronage at La Guardia and New York International to obtain

## Table 3

### Summary of Modes of Ground Transportation Utilized by Airport Population

### La Guardia Airport

### Friday—July 18, 1952

| | Auto | | Taxi | | Airport Coach | | City Bus | | Air | | Other | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % | Number | % | Number | % |
| *Air Passengers* | | | | | | | | | | | | |
| In (7,423) | 1,737 | 23.4 | 2,783 | 37.5 | 2,055 | 27.7 | 148 | 2.0 | 700 | 9.4 | – | – |
| Out (6,452) | 2,025 | 31.4 | 2,196 | 34.0 | 1,402 | 21.7 | 129 | 2.0 | 700 | 10.9 | – | – |
| Total (13,875) | 3,762 | 27.1 | 4,979 | 35.9 | 3,457 | 24.9 | 277 | 2.0 | 1,400 | 10.1 | – | – |
| *Spectators* | | | | | | | | | | | | |
| In (3,502) | 2,765 | 79.0 | 175 | 5.0 | 131 | 3.7 | 131 | 3.7 | 300 | 8.6 | – | – |
| Out (3,435) | 2,710 | 78.9 | 172 | 5.0 | 126 | 3.7 | 127 | 3.7 | 300 | 8.7 | – | – |
| Total (6,937) | 5,475 | 78.9 | 347 | 5.0 | 257 | 3.7 | 258 | 3.7 | 600 | 8.7 | – | – |
| *Employees* | | | | | | | | | | | | |
| In (4,118) | 2,516 | 61.1 | 23 | .6 | – | – | 1,461 | 35.5 | – | – | 118 | 2.8 |
| Out (4,118) | 2,500 | 60.7 | 7 | .2 | – | – | 1,413 | 34.3 | – | – | 198 | 4.8 |
| Total (8,236) | 5,016 | 60.9 | 30 | .4 | – | – | 2,874 | 34.9 | – | – | 316 | 3.8 |
| *Casuals* | | | | | | | | | | | | |
| In (8,311) | 7,960 | 95.8 | – | – | – | – | 351 | 4.2 | – | – | – | – |
| Out (6,948) | 6,819 | 98.1 | – | – | – | – | 129 | 1.9 | – | – | – | – |
| Total (15,259) | 14,779 | 96.9 | – | – | – | – | 480 | 3.1 | – | – | – | – |
| *Airport Population* | | | | | | | | | | | | |
| In (23,354) | 14,978 | 64.1 | 2,981 | 12.8 | 2,186 | 9.4 | 2,091 | 8.9 | 1,000 | 4.3 | 118 | .5 |
| Out (20,953) | 14,054 | 67.1 | 2,375 | 11.3 | 1,528 | 7.3 | 1,798 | 8.6 | 1,000 | 4.8 | 198 | .9 |
| Total (44,307) | 29,032 | 65.5 | 5,356 | 12.1 | 3,714 | 8.4 | 3,889 | 8.8 | 2,000 | 4.5 | 316 | .7 |

## Table 4

### Summary of Modes of Ground Transportation Utilized by Airport Population

New York International Airport

Friday—August 1, 1952

| | | Auto | | Taxi | | Airport Coach | | City Bus | | Air | | Other | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number | % | Number | % | Number | % | Number | % | Number | % | Number | % |
| *Air Passengers* | | | | | | | | | | | | | |
| In | (4,721) | 1,480 | 31.3 | 611 | 13.0 | 2,133 | 45.2 | 47 | 1.0 | 450 | 9.5 | – | – |
| Out | (4,406) | 1,669 | 37.9 | 525 | 11.9 | 1,718 | 39.0 | 44 | 1.0 | 450 | 10.2 | – | – |
| Total | (9,127) | 3,149 | 34.5 | 1,136 | 12.4 | 3,851 | 42.2 | 91 | 1.0 | 900 | 9.9 | – | – |
| *Spectators* | | | | | | | | | | | | | |
| In | (5,655) | 4,327 | 76.6 | 339 | 6.0 | 387 | 6.8 | 387 | 6.8 | 215 | 3.8 | – | – |
| Out | (5,596) | 4,279 | 76.5 | 336 | 6.0 | 383 | 6.8 | 383 | 6.8 | 215 | 3.9 | – | – |
| Total | (11,251) | 8,606 | 76.5 | 675 | 6.0 | 770 | 6.8 | 770 | 6.8 | 430 | 3.9 | – | – |
| *Employees* | | | | | | | | | | | | | |
| In | (4,237) | 3,093 | 73.0 | 7 | 0.2 | – | – | 1,019 | 24.0 | – | – | 118 | 2.8 |
| Out | (4,237) | 3,121 | 73.7 | 5 | 0.1 | – | – | 961 | 22.7 | – | – | 150 | 3.5 |
| Total | (8,474) | 6,214 | 73.3 | 12 | 0.1 | – | – | 1,980 | 23.4 | – | – | 268 | 3.2 |
| *Casuals* | | | | | | | | | | | | | |
| In | (8,192) | 8,192 | 100.0 | – | – | – | – | – | – | – | – | – | – |
| Out | (7,373) | 7,373 | 100.0 | – | – | – | – | – | – | – | – | – | – |
| Total | (15,565) | 15,565 | 100.0 | – | – | – | – | – | – | – | – | – | – |
| *Airport Population* | | | | | | | | | | | | | |
| In | (22,805) | 17,092 | 74.9 | 957 | 4.2 | 2,520 | 11.1 | 1,453 | 6.4 | 665 | 2.9 | 118 | 0.5 |
| Out | (21,612) | 16,442 | 76.1 | 866 | 4.0 | 2,101 | 9.7 | 1,388 | 6.4 | 665 | 3.1 | 150 | 0.7 |
| Total | (44,417) | 33,534 | 75.5 | 1,823 | 4.1 | 4,621 | 10.4 | 2,841 | 6.4 | 1,330 | 3.0 | 268 | 0.6 |

these data. Newark had just opened with a new terminal, and it was believed that data collected at that time would not be representative. This survey did not take into account the employee passenger cars parked in lots which are separate from the public lots.

Automobiles using the public parking lots represent the largest component of ground transportation serving the airport community. A substantial part of this activity is associated with air passenger movements. The remaining function of cars using the parking lots is to transport non-air passengers—sightseers, businessmen and visitors with air passengers who come to the airports.

During the summer when capacity volumes are experienced, parking lot patrons were questioned as they left the lots concerning the purpose and length of their visit and their residence. The objectives of this survey were:

1. To determine the proportions of parking lot patronage related to the various components of air traffic, sightseer volumes, and other airport activities on an average day and on a Sunday.

2. To determine the number of people involved in the various segments of parking lot patronage.

3. To determine the duration of parking by the various segments of parking lot patronage.

It is important to sketch the dimensions of the activity that was studied. On an average August day more than 12,000 people in 4,000 cars used the parking lot at the New York airports, while on Sunday more than 19,000 people in almost 6,000 cars were parking lot patrons. An average day's 12,000 people comprise 3,600 air passengers, accompanied or met by 4,400 persons; 1,300 sightseers, 1,000 others, and 1,700 children from all groups. Sunday's 19,900 patrons may be resolved into 4,500 air passengers, accompanied or met by 6,000 persons; 4,000 sightseers, 1,500 others and 3,000 children from all groups. There are, however, substantial differences in the way these figures are shared by the two airports.

### How Airport Characteristics Differ

La Guardia is characterized by the staple, business-type traveler and International by the vacationer and sightseer. This is reflected in the higher loading per car in greater weekend activity at International.

Thus it is observed that 800 more persons use the lots at New York International Airport on Sunday, while the same number of cars are counted at both airports. More sightseers, more air passengers, and more visitors with air passengers use New York International on Sunday. On the average, however, only 100 more people use the lots at International with 300 fewer cars. It may seem that International shows more parking patronage though fewer cars primarily because of the many more sightseers visiting this airport.

Figure 2 shows the average cars per day in August by purpose of visit. Classification of cars by purpose of visit is defined below.

1. To airport—cars actually transporting one or more people to the airport for the purpose of departing on an outbound flight.

2. From airports—cars actually transporting one or more people from the airport who arrived on an inbound flight.

3. To and from airport—cars brought to the airport by an air passenger and left in the airport parking lot for the duration of the air trip.

4. Sightseers—cars transporting only people who have come to the airport to sightsee.

5. Missed air passengers—cars coming to the airport for meeting or delivering an air passenger, but for any reason not accomplishing either.

6. Tickets and reservations—cars coming to the airport for buying tickets, making reservations or inquiring about flights.

7. Employees and air crews—cars brought to the airport for transporting an employee, an air crew member, or a visitor to any employee.

8. Business—cars brought to the airport for transporting people who have concessions, airline, or government business at the airport. Applicants for jobs, airport-employee relative who visits the airport infrequently. People with business relating to air-freight movement. People meeting or seeing an air passenger off but who did not transport the air passenger, and people with business relating to the movement of air passengers, such as picking up luggage or a car left in the lot by a departing passenger.

9. Miscellaneous—cars brought to the airport for transporting people whose exclusive purpose is to use the restaurant or cocktail lounge and other purposes.

Figure 2 shows that Sunday is the highest day of the week, Saturday following, caused by the great number of sightseers visiting the airport.

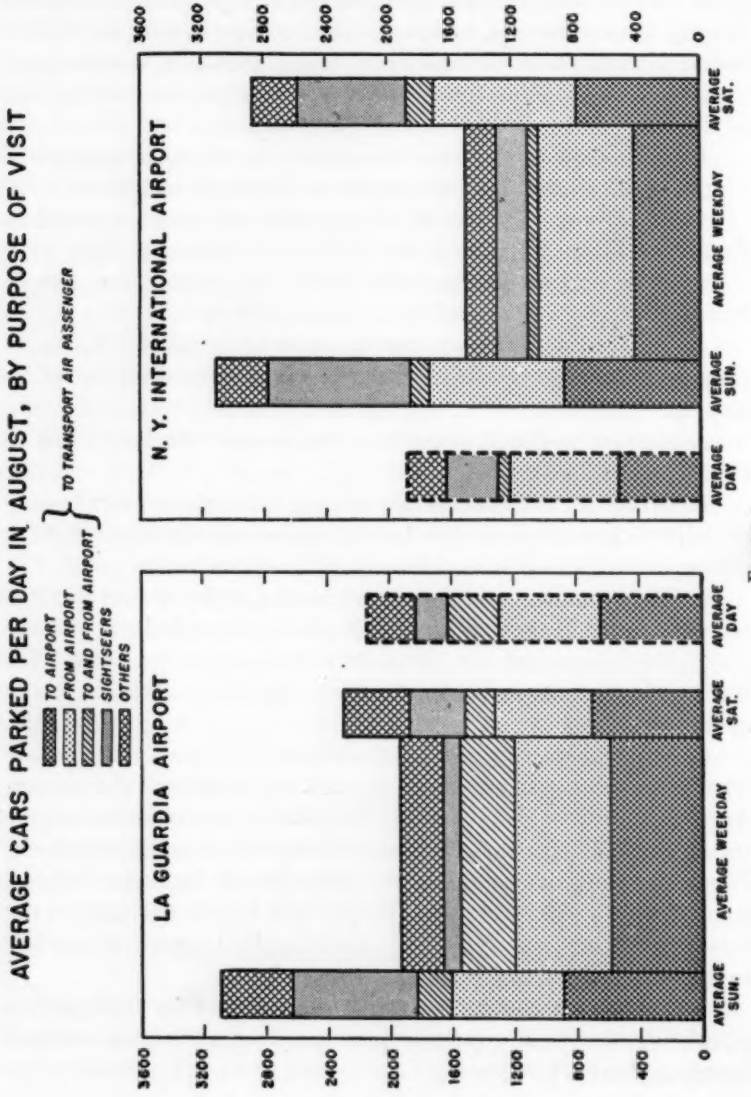


FIGURE 2

For every scheduled flight arriving or departing from New York International, an average of *seven parking lot cars are used to transport air passengers, but only three such cars at La Guardia.* The appropriate cars per flight are indicated in the following table:

| *Type of Flight* | *Cars per Flight* NYIA | LGA |
|---|---|---|
| Domestic Coach | 5 | 6 |
| Domestic Regular | 6 | 3 |
| Total Domestic | 6 | 3 |
| Overseas Tourist | 8 | |
| Overseas Regular | 10 | |
| Total Overseas | 9 | |
| Total Reduced Fare | 7 | 6 |
| Total Regular Fare | 7 | 3 |
| Gross Total | 7 | 3 |

A substantially greater proportion of the cars used for air passengers is brought to the airport for pleasure trips at New York International.

The proportion of air travelers who are accompanied by visitors is substantially higher at New York International Airport (i.e., 28 percent versus 18 percent at La Guardia) and to some extent, the number of visitors per accompanied passengers. The significance of these people lies in the magnitude of their contribution to the airport population.

The preponderance of sightseers at New York International involved greater Sunday volumes as well as a heavy contribution from greater midweek activity. Most of these are drawn to the International Airport from Brooklyn and Queens. It may be noted also that essentially all sightseers at the airports are transported by cars using the parking lots.

### Type of Air Travel Denotes Parking Time

Table 5 shows the length of time a car is parked in a parking lot at both La Guardia and New York International Airport, and shows that long term parking is devoted to the exclusive convenience of the

Table 5

How Long Is the Average Car Parked?

| Purpose of Visit | La Guardia Average Day | La Guardia Week-day | La Guardia Week-end | N.Y. International Average Day | N.Y. International Week-day | N.Y. International Week-end |
|---|---|---|---|---|---|---|
| | — Hours — | | | | | |
| All Purposes* | 1.5 | 1.3 | 1.5 | 1.6 | 1.6 | 1.5 |
| To Transport Air Passengers | 1.2 | 1.1 | 1.3 | 1.6 | 1.6 | 1.6 |
| To Airport | 1.2 | 1.1 | 1.3 | 1.4 | 1.4 | 1.5 |
| From Airport | 1.2 | 1.1 | 1.2 | 1.7 | 1.8 | 1.6 |
| To and from Airport (Days) | (1.8) | (1.7) | (2.6) | (4.8) | (4.4) | (5.3) |
| To Transport Sightseers | 1.4 | 1.5 | 1.4 | 1.3 | 1.3 | 1.3 |
| To Transport Others | 2.1 | 1.8 | 1.9 | 1.9 | 2.0 | 1.9 |
| Missed Air Passengers | 1.3 | 1.1 | 1.6 | 2.5 | 2.6 | 2.3 |
| Tickets and Reservations | 0.8 | 0.7 | 1.0 | 0.8 | 0.8 | 0.7 |
| Employees and Air Crews | 5.1 | 5.4 | 5.7 | 3.6 | 3.8 | 3.5 |
| Business | 1.6 | 1.8 | 1.5 | 1.6 | 1.6 | 1.6 |
| Miscellaneous | 1.3 | 1.5 | 0.7 | 2.4 | 2.6 | 1.5 |

* Average duration of parking is computed only for cars parked less than one day.

air traveler. Almost half of this parking is involved with air passengers traveling to and from foreign points at New York International. La Guardia, however, has four times the volume of International in this segment of the parking business. Most of it is due to the business traveler. Eighty percent of La Guardia's long term parking involved an air passenger making a business trip, while this proportion at New York International is 60 percent.

The average air passenger who leaves his car at New York International is away twice as long as the same type of passenger at La Guardia. However, as the length of parking increases, the proportion of business travelers decreases, so that the very long parkers (over five or six days) tend to be pleasure, if not luxury travelers. This study is important in determining the type of parking facility to provide.

A convenient measure for comparing parking lot usage to air passenger traffic is the ratio of cars used to transport air passengers to total air passengers. At La Guardia this measure yields a ratio of .146 and at New York International .181. The breakdown in this ratio at New York International for domestic and overseas passengers is .162 and .203, respectively.

Table 6 gives the number of cars and the occupancy of each pas-

senger car using the airport parking lots on an average August day, and Table 7 gives information on a Sunday in August when parking lot usage is highest. Parking lots must be planned to handle peak traffic in the same manner as we plan highways to handle peak loads.

Table 6

How Many Cars and People Use the Airport Parking Lots on an Average August Day?

| Purpose of Visit | Cars | Passengers | | | | | |
|---|---|---|---|---|---|---|---|
| | | Passengers in Cars Leaving Airport | | Visitors with Air Passengers | | Air Passengers | |
| | | Adults | Children | Adults | Children | Adults | Children |
| *La Guardia* | | | | | | | |
| All Purposes | 2,140 | 4,424 | 766 | 2,171 | 372 | 1,892 | 211 |
| To Transport Air Passengers | 1,613 | 3,334 | 486 | 2,171 | 372 | 1,892 | 211 |
| To Airport | 647 | 1,233 | 205 | 1,233 | 205 | 729 | 97 |
| From Airport | 651 | 1,703 | 271 | 938 | 167 | 766 | 103 |
| To and from Airport | 315 | 398 | 10 | — | — | 398 | 10 |
| To Transport Sightseers | 213 | 462 | 202 | | | | |
| To Transport Others | 314 | 628 | 78 | | | | |
| *New York International* | | | | | | | |
| All Purposes | 1,862 | 4,580 | 921 | 2,280 | 364 | 1,693 | 238 |
| To Transport Air Passengers | 1,292 | 3,308 | 529 | 2,280 | 364 | 1,693 | 238 |
| To Airport | 510 | 1,172 | 200 | 1,172 | 200 | 665 | 73 |
| From Airport | 709 | 2,037 | 328 | 1,108 | 164 | 929 | 164 |
| To and from Airport | 73 | 99 | 1 | — | — | 99 | 1 |
| To Transport Sightseers | 338 | 824 | 312 | | | | |
| To Transport Others | 232 | 448 | 80 | | | | |

Table 8 shows the purpose of the visit of those patrons using the parking lot at both La Guardia and New York International Airport.

## Other Studies Aid Ground Planning

To determine what highways carried traffic to and from the airport, an origin-destination study was made as a part of this survey. The origin of this traffic is designated as east of the Hudson, west of the Hudson, and outside of the metropolitan area.

Another study was made to determine in each purpose-of-visit category the length of parking in the parking areas. In a survey of

Table 7

How Many Cars and People Use the Airport Parking Lots on a Sunday in August?

| Purpose of Visit | Cars | Passengers | | | | | |
|---|---|---|---|---|---|---|---|
| | | Passengers in Cars Leaving Airport | | Visitors with Air Passengers | | Air Passengers | |
| | | Adults | Children | Adults | Children | Adults | Children |
| *La Guardia* | | | | | | | |
| All Purposes | 2,908 | 6,663 | 1,577 | 2,842 | 616 | 2,096 | 112 |
| To Transport Air Passengers | 1,717 | 3,897 | 653 | 2,842 | 616 | 2,096 | 112 |
| To Airport | 839 | 1,784 | 421 | 1,784 | 421 | 1,041 | 75 |
| From Airport | 669 | 1,871 | 232 | 1,058 | 195 | 813 | 37 |
| To and from Airport | 209 | 242 | — | — | — | 242 | — |
| To Transport Sightseers | 752 | 1,852 | 765 | | | | |
| To Transport Others | 439 | 914 | 159 | | | | |
| *New York International* | | | | | | | |
| All Purposes | 2,932 | 7,494 | 1,585 | 3,177 | 335 | 2,396 | 247 |
| To Transport Air Passengers | 1,747 | 4,565 | 535 | 3,177 | 335 | 2,396 | 247 |
| To Airport | 819 | 1,958 | 197 | 1,958 | 197 | 1,008 | 47 |
| From Airport | 824 | 2,415 | 338 | 1,219 | 138 | 1,196 | 200 |
| To and from Airport | 104 | 192 | — | — | — | 192 | — |
| To Transport Sightseers | 868 | 2,259 | 893 | | | | |
| To Transport Others | 317 | 670 | 157 | | | | |

2,140 cars at La Guardia, 561 vehicles parked 45 minutes or less; 886 parked over 45 minutes but less than an hour and 45 minutes; 265 cars parked between 1 hour and 45 minutes and 2 hours and 45 minutes. In other words, 1,712 vehicles parked less than three hours. The only other significant parking fact in this survey was that 130 vehicles parked for almost two days. These were for air passengers who had taken a two-day trip by air, leaving the car at the airport during the entire trip.

At New York International Airport, 375 vehicles parked less than 45 minutes; 886 between 45 minutes and an hour and 45 minutes; and 356 vehicles between 1 hour and 45 minutes and 2 hours and 45 minutes. A total of 1,616 vehicles out of 1,862 vehicles studied parked less than three hours.

Eighty percent of the vehicles studied at La Guardia Airport parked less than three hours and 87 percent of vehicles studied at New York International Airport parked less than three hours.

Table 8

WHAT IS THE PURPOSE COMPOSITION OF THE LOT TRAFFIC BY DAY OF THE WEEK?

| Purpose of Visit | Average Day | Weekday | Saturday | Sunday |
|---|---|---|---|---|
| *La Guardia* | | | | |
| All Purposes | 100% | 100% | 100% | 100% |
| To Transport Air Passengers | 78 | 82 | 72 | 61 |
| To Airport | 30 | 30 | 30 | 29 |
| From Airport | 30 | 32 | 28 | 23 |
| To and from Airport | 15 | 18 | 8 | 7 |
| Missed Air Passengers | 3 | 2 | 6 | 2 |
| To Transport Sightseers | 10 | 6 | 16 | 26 |
| To Transport Others | 12 | 12 | 12 | 13 |
| Tickets and Reservations | 3 | 4 | 3 | 1 |
| Employees and Air Crews | 4 | 4 | 1 | 3 |
| Business | 4 | 3 | 7 | 8 |
| Miscellaneous | 1 | 1 | 1 | 1 |
| *New York International* | | | | |
| All Purposes | 100% | 100% | 100% | 100% |
| To Transport Air Passengers | 71 | 74 | 66 | 61 |
| To Airport | 28 | 27 | 27 | 28 |
| From Airport | 38 | 41 | 36 | 28 |
| To and from Airport | 4 | 5 | 2 | 3 |
| Missed Air Passengers | 1 | 1 | 1 | 2 |
| To Transport Sightseers | 18 | 14 | 25 | 30 |
| To Transport Others | 11 | 12 | 9 | 9 |
| Tickets and Reservations | 3 | 3 | 3 | 2 |
| Employees and Air Crews | 2 | 3 | 1 | 2 |
| Business | 6 | 6 | 5 | 5 |
| Miscellaneous | 0 | 0 | 0 | 0 |

Table 9 and Table 10 show the average August day cars in each purpose-category by duration of parking at La Guardia Airport and New York International Airport, respectively.

Employee lots were not included in this study of parking lots, but it is well to point out that the employee passenger car load is a very important and integral part of the whole transportation system and cannot be ignored. In fact, the peak movement is the result of the influx of employees during the morning and evening hours, taking place between 7:30 and 8:30 A.M. and between 3:00 and 4:00 P.M. Employees coming to work comprise about 9 percent of the total traffic into the airport in the morning, and over 8 percent in the

## Table 9

### Average August Day Cars in Each Purpose Category by Duration of Parking

### La Guardia Airport

| Purpose of Visit | Duration of Parking: Less than 1 Hr., 15 Min. | 1 Hr., 15 Min. through 3 Hrs., 14 Min. | 3 Hrs., 15 Min. through 6 Hrs., 14 Min. | 6 Hrs., 15 Min. through 12 Hrs., 14 Min. | Greater than 12 Hrs., 14 Min. | All Parking |
|---|---|---|---|---|---|---|
| All Purposes | 1,277 | 476 | 50 | 196 | 141 | 2,140 |
| To Transport Air Passengers | 949 | 327 | 33 | 163 | 141 | 1,613 |
| To Airport | 483 | 153 | 10 | 1 | — | 647 |
| From Airport | 466 | 174 | 11 | — | — | 651 |
| To and from Airport | — | — | 12 | 162 | 141 | 315 |
| To Transport Sightseers | 135 | 74 | 4 | — | — | 213 |
| To Transport Others | 193 | 75 | 13 | 33 | — | 314 |
| Missed Air Passengers | 32 | 21 | 2 | — | — | 55 |
| Tickets and Reservations | 65 | 8 | — | — | — | 73 |
| Employees and Air Crews | 30 | — | 10 | 32 | — | 72 |
| Business | 52 | 38 | 1 | 1 | — | 92 |
| Miscellaneous | 14 | 8 | — | — | — | 22 |

## Table 10

### Average August Day Cars in Each Purpose Category by Duration of Parking

### New York International Airport

| Purpose of Visit | Duration of Parking: Less than 1 Hr., 15 Min. | 1 Hr., 15 Min. through 3 Hrs., 14 Min. | 3 Hrs., 15 Min. through 6 Hrs., 14 Min. | 6 Hrs., 15 Min. through 12 Hrs., 14 Min. | Greater than 12 Hrs., 14 Min. | All Parking |
|---|---|---|---|---|---|---|
| All Purposes | 1,018 | 678 | 79 | 29 | 58 | 1,862 |
| To Transport Air Passengers | 660 | 497 | 63 | 15 | 57 | 1,292 |
| To Airport | 298 | 200 | 12 | — | — | 510 |
| From Airport | 362 | 297 | 49 | 1 | — | 709 |
| To and from Airport | — | — | 2 | 14 | 57 | 73 |
| To Transport Sightseers | 220 | 115 | 3 | — | — | 338 |
| To Transport Others | 138 | 66 | 13 | 14 | 1 | 232 |
| Missed Air Passengers | 7 | 14 | 3 | 1 | — | 25 |
| Tickets and Reservations | 51 | 4 | — | — | — | 55 |
| Employees and Air Crews | 18 | 11 | 6 | 12 | — | 47 |
| Business | 60 | 37 | 3 | 1 | 1 | 102 |
| Miscellaneous | 2 | — | 1 | — | — | 3 |

afternoon. The rest of the day, traffic flows into and out of the airport at a rather uniform rate of almost 5 percent of the total per hour.

This indicates that an airport road receives a rather uniform flow during the off peak hours, and considerable use of the roadways from 7 A.M. until midnight. There is considerably more transportation of persons by passenger cars and taxis. Where a city handles around 20 percent of its public transportation by bus, at these airports only 5 percent is handled by bus.

### Ground and Air Problems Conflict

The highway traffic engineer is principally interested in ground transportation and its terminals while the aeronautical engineer is interested in runways, taxiways, aprons, etc. Both meet on a common ground when it comes to planning an airport terminal building and its accommodations for ground transportation.

One of the most perplexing problems in airport design is the basic conflict between the two forms of transportation serving an airport. The airplane needs vast expanse to operate which tends to stretch the terminal out in an elongated building. Such a building is not suitable for handling air passengers while on the ground. It makes walking distances prohibitive, and causes circuitous routing of ground vehicles.

A large plane takes from 150 to 200 feet just to park at gate position. Twenty to thirty gate positions necessary at major airports require a frontage area from three-quarters to a mile long. Add to this the distance one must walk through the parking area and through the terminal and you are confronted with walking distance approaching one and a half miles. At airports where the passenger will likely have baggage to carry, we try to limit his walking distance to under 750–800 feet.

To meet this very real problem, various schemes of terminal design have been developed. The semicircular design brings the ends of the terminal and the adjacent plane positions in toward the center. The multiple finger design is another plan which condenses the area. The combination of the two designs condense the area to a minimum, thereby reducing walking distance and is also adapted to

further expansion without stretching the area beyond reasonable limits.

Under prevailing conditions the air terminal building, like all other transportation terminals, is not self-sufficient. It cannot meet expenses by assessment to the transportation units only, whether they be air, bus, passenger cars or taxis. Such facilities as restaurants, drug stores, and barber shops are necessary services for the air traveler. These, together with gift shops, wearing apparel shops, etc., are provided to help defray expenses of the airport.

The ideal location for these activities would be right in the center of the building in a semicircular plan where passengers can conveniently reach them with minimum walking distance. Ticket offices, baggage rooms, information booths, and other necessary services must also be conveniently located. Briefly, these necessary services must be located as nearly as possible in the pedestrian traffic stream without causing congestion. The data as illustrated give a rather complete quantitative analysis of the facilities needed. Fitting them into an integrated plan is a task for the airport and traffic engineers.

## Long-Range Planning Essential

The planning of airport roadways involves much the same problem as that encountered in planning a city street system, except that we have vast expanses of area to work in and are not confined to a certain right-of-way. Although we do have considerably more freedom in our design, it certainly requires careful planning to keep the airport from becoming antiquated with the fast-growing air travel industry. It requires a carefully laid-out master plan with areas designated for specific buildings, parking facilities, aprons, roadways, etc. Rights-of-way should be established to prevent future encroachments which would interfere with the free movement of traffic.

In our thinking on future improvements, we have established limited access roadways, service roadways, parking terminal areas, facilities for loading and unloading of mass transportation units, taxi facilities, and every known facility necessary to accommodate the ground transportation units which might be expected to serve the airport.

Our engineers think it advisable to segregate the passenger-hand-

ling facilities from the cargo-handling facilities. Such an arrangement requires a separate roadway network, at least in part. Rightly so, for cargo trucks have no place in the vicinity of the passenger terminal nor is it desirable to take all of the passenger vehicles past the cargo-handling operation.

In the layout of the roadway system, we have attempted to achieve the idealistic arrangement—roadways for movement only. Such a scheme necessitates careful study of requirements for other than moving traffic.

Parking lots must be located as close to the destination of the airport users as is physically possible. They must be designed to accommodate peak loads both during the week and on Sunday when they are used principally by sightseers. The parking lots must, therefore, be designed to provide flexibility as use demands. We have experimented with almost every conceivable design of entrance and exit at the same location, thereby keeping the cost of operation to a minimum. In lots of 500 or more capacity, an entrance and exit combined complicates the operation and congestion results on the approach roadways.

Our studies show that an entrance booth can accommodate 250–300 vehicles per hour per lane. In lots of several hundreds capacity, such as exist at major airports, the entrance can block traffic on the main airport highways. The frequency of expected arrival, therefore, determines where the entrance should be located and how much reservoir space must be allowed to absorb the expected traffic. This means that a lot placed adjacent to a principal roadway might have its booths recessed in the parking lot.

The lot should be designed to obtain the greatest capacity in the smallest amount of space. Care must be exercised in planning the road network to prevent entering and exiting traffic using the parking lot, from interfering with each other.

Facilities for short-time parking for people to pick up a relative, obtain a ticket, or conduct short-time business at the airport are a necessity. The areas must be conveniently placed or drivers will park in the roadways, obstructing movement. Where possible, we have provided a metered area for this purpose convenient to the terminal, but in a location which will not interfere with traffic on the principal roadway serving the terminal.

With the low tourist rates now offered by airlines, air travel is no longer considered "plush travel" serving only a limited group. It is now as low as rail travel on many trips. Likewise, many travelers are now using public ground transportation to and from the airport. The regular transit lines serving large metropolitan airports will provide frequent and dependable service when passenger loads make it economically feasible. The largest groups using public transit are the employees numbering 10,000–15,000 in a large airport.

During one month the three New York metropolitan airports drew almost 300,000 spectators. As these airports are enlarged and provide more and more attractions, this number will undoubtedly increase materially. Bus stops are conveniently provided near the main entrance to the passenger terminal and at all work-areas. Where possible these loading and unloading areas are offset from the main roadways where they present no interference with other traffic. Zones to accommodate three or four units simultaneously have proved adequate.

Taxis, which carried about 35 percent of the air passengers at La Guardia and about 12 percent at New York International, must receive serious consideration in the layout of the roadway system and its accompanying terminals. A survey of the rate of arrivals of taxis show that as many as 150 units arrive in a single half-hour period. If a flight is delayed just a few minutes, an accumulation of 150 vehicles on the roadway system in the vicinity of the passenger terminal could completely block the roadway to other essential movement. The particular requirements of this unit of transportation necessitates the inclusion of a taxi parking or storage area. The size of this area depends upon the number of flights. The peak occurs when several flights arrive within minutes of each other.

The area set aside for taxi storage must be in close proximity to the terminal. We allow only two or three to park at the exits and call them from the storage area as needed. In the event the area cannot be placed in view of the passenger terminal exit doorways, some automatic or manually operated signal is used to call taxicabs from this storage area as needed.

Many airports are served by special buses referred to as airline coaches. Their service is scheduled to meet the schedules of the air-

Aerial view of Newark Airport Terminal illustrates basic layout.

lines. These buses usually originate in the city business area at an airline office or terminal. They do not operate on a rigid schedule as do city transit line buses.

The magnitude of this service again depends upon the location of the airport. It does constitute an important mode of transportation for air passengers. Since these units are scheduled to meet flights, provision must be made to store up to ten or twelve coaches awaiting an incoming flight, in a location easily accessible to the passenger terminal exit.

The photograph of new Newark Airport passenger terminal illustrates the basic arrangement of facilities for ground transportation units. All types of ground units have their individual facilities, leaving the principal roadways free for movement. Here we were able to provide convenient parking for the passenger car, taxi and bus storage readily accessible to the terminal, and public bus transportation just 200 or 300 feet from the terminal.

This terminal is located practically at the intersection of two of New Jersey's great highways, N.J. 25 and the New Jersey Turnpike. Newark, Jersey City and Elizabeth are just a few minutes' travel time away.

This article attempts to indicate the basic data needed in the planning of ground transportation facilities. If the airport is planned to grow with the ever-increasing air industry, there must be correlations such as our aviation department have assembled, to give proper consideration to the ground facilities.

Aerial view of Newark Airport Terminal illustrates basic layout.

# An Appraisal of Shopping Centers

KENNETH C. WELCH

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WHAT are primary and secondary locations? Will centers having an acceptable presentation of shopping goods with walking distances of 300 to 500 feet prove better long-range investments than those with 1000- to 1500-foot distances?

This article is in a way a review and a critique of current trends in the design and planning of regional shopping centers. It will discuss the true regional center which provides the retail service to the outlying urban area that heretofore the retail area of the central business district has provided. It will not discuss the real estate promotion that is an enlarged neighborhood center, featuring primarily convenience goods and whose tenants are mostly chain stores.

As the automobile has completely changed the pattern, area, density and social characteristics of cities, it is only logical that it should vitally affect our shopping habits.

The department store, which in the past has been king of the retail field and creator of prime locations downtown, has lost its crown to the supermarket. Not only was it the main attraction, but by attracting competing specialty stores to the same area, it produced a cumulative pull that has made downtown great. The same can hold true of the regional center which provides the parking facilities of a quantity and quality that consumers will demand in the very near future.

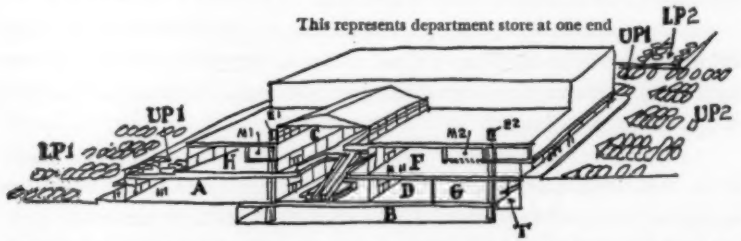
The new regional center, and also the large neighborhood center for that matter, competes with the downtown retail area but it also completely complements it and in the large city is quite essential to the well-being of the downtown stores. Downtown, after the many healthy and hopeful adjustments that are taking place, is and always will be more important as a regional center than any one outlying

center, which caters to the automobile-driving consumer, can ever be.

Most department stores, because they have a big investment downtown, have only recently realized that to hold their position they must take their wares to the customer. In the interim they have not fared too well.

In the Controllers' Congress Merchandising Operating Results for 1954 appears the statement, "The observation must be made that departmentized stores are failing to maintain their status quo." It is clearly pointed out that the department store and the departmentized specialty store are far from keeping pace in their increased sales with the increases in consumer purchasing power.

The annual Harvard Report for a departmentized store operation in 1953 shows sales increasing 5 percent more than in 1950 but




Selling area H, approximately 60 to 70 ft. deep, has direct access to upper level roof parking UP1 and to concourse upper level. It would be ideal for such high productivity shops as shoes, accessories, etc. It has a service mezzanine M1 (which can be extended for future expansion) and which connects via common freight elevators to basement service B, where they could also have storage space.

Upper level parking UP1 is on roof of stores A. Continuous circulation is provided around center connecting with upper level parking UP2. In other words the upper level has parking on four sides.

Lower level parking—LP1—would serve three sides of the lower level, the fourth side being the truck passage T.

Common elevators E1 could have contact with concourse to serve concessions.

Selling area A, 130 to 140 ft. deep, has direct access from parking LP1 and from main concourse level C1. All stores in spaces A, H and F could receive deliveries up until 10 a.m. or noon (depending upon opening time) direct from curb. Area D has direct contact with truck passage. Stores in A could have service area in basement B.

The two level concourse—enclosed or open, depending upon climate—with planting or concessions. Bridges with or without concessions would cross on upper level every 100 ft. Common escalators would prominently connect the two levels.

Selling level F 140 to 150 ft. deep connects with upper level parking and concourse. Service mezzanine at M2 which could be extended later.

Retaining wall or bank separates parking levels.

Sales area G can vary in depth depending upon how much service area is required in G area to serve stores in either D or F. Heavy, mass merchandise should be located here like appliances, hardware, mass food sales.

Service area B need be built under only part of center—when it is necessary for common freight elevators to reach stores in A or service mezzanine M1.

Truck passage T could ramp down in middle of center to reach basement B.

DIAGRAMMATIC CROSS SECTION OF A TWO LEVEL SHOPPING CENTER

the consumer income after taxes was 20 percent higher. During this period food purchases were increased by 24 percent, gasoline 30 percent and rent and utilities 25 percent. Clearly the branch store properly planned can be one answer to this problem.

Considering the fact that the department store has been the main stay and prime pulling power and the factor creating A–1 locations in most cities, it is surprising how few department stores have produced branches in real regional centers.

### What Is a Regional Center?

To comprehend what we mean by a real regional center we should attempt at least to define it. It is in reality a branch of the central district shopping goods area. It renders an important part of the service that downtown has provided in the past.

It should have 500,000 square feet of gross rentable area catering 85 percent to the shopper on private wheels, with at least 65 percent sales in the fashion shopping goods category and with a parking index of not less than 7.

Only a half-dozen such centers are in operation, mostly in the west and with perhaps the country's largest one, J. L. Hudson Company's Northland, in Detroit. Another half dozen or so have been announced as being in the final planning, leasing or construction stages in Baltimore, Cleveland, Hamilton, Ontario, Minneapolis and a few other large cities.

Well-planned shopping goods centers, however, are those best designed to make pedestrian shoppers out of automobile drivers and to concentrate that pedestrian traffic, as it has been downtown, to produce the maximum impulse-sales so vital to maximum productivity.

They are planned so that people bring their private parcel carrier just as close to the group of stores as possible. In other words, they have fairly good selections and are convenient because they have minimum walking distances from parked car to store and from store to store, pedestrianwise. This brings up two questions; how can pedestrian traffic be concentrated to create the maximum number of prime locations, and what are reasonable walking distances?

We get a picture of the value of prime locations by examining

the eighth edition of "Percentage Leases," published by the National Institute of Real Estate Brokers. The so-called prime locations, especially in the older established central business district, obviously produce a higher sales productivity and greater rent per square foot.

### Prime Location Defined

It is obvious that the prime location is the one with a *maximum amount of pedestrian traffic passing a front foot of a given store or display*. It is the best block on the main street as opposed to a side or back street. It is also evident that the center designed on the ribbon principle (insisted upon by most chain operators), if it is large enough to create a pull, must unnecessarily disburse its pedestrian purchasing power.

In women's clothing, eliminating the exceptional operation (based on the "better mousetrap" theory) or obviously poor ones, prime locations run pretty close to $100 sales per gross square foot and conversely, the secondary location has a productivity of less than half of this. Men's stores produce an average of $73 per square foot in downtown prime locations, $50 in secondary.

Drug stores sell many impulse items today. If we take all the forty-three drug stores listed, we find that downtown prime locations average $120 a square foot as compared with the secondary $64, and the outlying prime $81 versus outlying secondary at $52. Of course they do not define prime and secondary locations but they are obviously referring, in the central district, to locations with high pedestrian traffic.

Even so it is quite apparent that A-1 locations are created for shopping goods stores based on pedestrian traffic, whereas vehicle traffic is beneficial and necessary for such retail outlets as filling stations, some types of restaurants, and other drive-in operations.

The decentralized commercial area obviously must appeal primarily to the automobile-driving consumer. To do this it must have, first, a highway capacity to serve the terminal area provided, and second, sufficient terminal area to handle at least 80 percent to 90 percent of the peak demand. This peak in convenience goods can be weekly or daily, whereas in shopping goods it is seasonal. Downtown could always put on more streetcars and decrease their headways,

but you cannot create parking spaces out of thin air except as you harmfully disburse parking throughout adjacent residential areas.

### Importance of Parking to Centers

Let us examine the importance of parking, of a given quantity and quality, to the regional center.

Recent studies, published by the Highway Research Board in five parts, on parking as affecting business are admittedly pilot studies but they furnish a considerable amount of useful data. These studies indicate increasing business property values downtown but show that this area's fundamental function is as a business center rather than as an expanding retail center and, accordingly, that outlying retail areas on the whole are depreciating the central district retail property values.

Above all the studies show that an ample selection of shopping goods—primarily fashion apparel and home furnishings—in the central district in ample breadth (price line) and depth (styles, color, sizes, etc.) is the dominant pulling factor. It can overcome the congestion, lack of parking and inconvenience of downtown.

This basically confirms the current application of Reilly's Law of Retail Gravitation which in our opinion is the only logical method of determining shopping goods sales potentials for a given location and size.[1] This law says that consumers are attracted to shopping goods centers in direct proportion to the presentation of shopping goods therein and inversely as the square of the time distance from a given market.

However, the great majority of the hundreds of shopping centers being promoted today in any one case are comparatively minor detractions from downtown, but they have affected downtown because of their considerable numbers. Accordingly we can say that a shopping goods center must reach a certain size to create a given pull. That size we have determined in our definition of a regional center.

The question of what constitutes reasonable walking distances, in the light of some of the new plans for shopping centers, needs further discussion. In factual data on this subject, R. H. Burrage of the Bureau of Public Roads pertinently says, "If walking distance

[1] See *Urban Land*, November, 1953.

is not considered to be a factor then there is no parking problem in any city." He summarizes the results of comprehensive parking studies of a hundred cities but acknowledges the obvious fact that it is economically impractical to install parking facilities exactly where they are needed. This is not true, of course, in the integrated, well-planned center which has complete control of terminal, generator, and distances.

It is also possible through the use of parking authorities—and admitting it is a governmental function—to place parking facilities very close to where they are most needed in many central districts. This has been done in plans for Pittsburgh's North Side and could be done in Grand Rapids. Mr. Burrage mentions the fact that many parkers are unwilling to walk even as much as the median distances computed.

It is also well to remember that this is a review of what exists in congested city centers and not what can be realized in a well-planned shopping goods area. As we have said, considerable competition exists between downtown and the large regional center. This is evidenced by what has happened initially to downtown sales in some stores in Detroit and St. Louis because of the "shock treatment" of new large outlying centers.

### Problems of Downtown Parking

We have only to compute the parking index of any large city central district to ascertain that only token parking can be provided. Further, and so important from the business standpoint, is the direct conflict between the all-day workers' low turnover parking space and the short-term shoppers' space. This problem is almost non-existent in the integrated center.

Mass transportation, which is having difficulties in all cities, must in some manner continue to serve the great majority of the people going downtown. The parking index (number of car spaces per gross square feet of building area) of any large city is less than one as compared with the minimum of seven for the truly regional suburban center.

Dayton, Ohio, with a metropolitan population of close to 500,000, made a comprehensive parking study in 1952. Dayton has

an unusual amount of downtown off-street parking for a city of this size. Its parking index is 1.17 with over eight million square feet of commercial area but with only two and a half million in retail area.

Most downtown parking is not convenient. The walking distances are too great, one is inconvenienced by the wait necessitated, or car fenders bumped by attendants.

Mr. Burrage of necessity discusses all classes of downtown parkers: the illegal curb, off-street free (private parking), curb pay, curb free and off-street pay.

### Downtown and Center Parking Compared

First, the illegal, which ranges from 6.2 percent to 19.4 percent of all parkers, depending upon the size of the city (average from 150 to 270 feet with 200 feet or less for cities up to 200,000 population).

Off-street free ranges from 158 up to 365 feet. This is mostly space designed by the landlord to be convenient for his all-day-worker tenant.

One of the most successful supermarket chains, constructing unusually large units (up to 40,000 square feet gross area), insists that it have 400 spaces in such a unit convenient only to its store, with a maximum walking distance of 200 feet and preferably only 150 feet. The chain learned by long and successful experience that this is the maximum distance people will walk willingly, and also a distance people will carry packages willingly without the extra payroll expense of manned parcel pickups. *Accordingly we can establish what can be called a "convenient" standard for shoppers' walking distances of not more than 300 feet with 200 feet preferable.*

The very large centers today comprise an area of a million square feet and more, and walking distances (even utilizing the mall principle which basically is a two-sided pedestrian street), extend from one end of the stores to the other, a third of a mile or more. In some cases this exceeds the walking distance from one end to the other of the concentrated retail area in the central district. Many parking bays are 500 feet deep and because of the 100 or more acres in the center it is often necessary during seasonal peaks to have to walk well over 1,000 feet from where one can easily park to a destination in a given store.

It can be argued that people are willing to do this particularly in December; but in many other normal peaks when only half of the parking space is used, customers still have to walk farther than our "comfort" standard of 200 to 300 feet.

Parking and reparking is a common practice in off seasons in large centers designed so that this can be done easily. The fact remains that these large centers, in which the central mall is a third of a mile or more long, are really a series of centers from the pedestrian viewpoint.

It is also true that most central districts have different shopping areas designed to appeal to different income groups or social strata. This same thing can happen in the outlying center, but as a rule the area has not been planned with this result in mind.

### Four Basic Center Plans Compared

Today, however, there are designs and trends toward designs which can materially reduce walking distances in medium-sized centers as compared with the strip or with the U-type.

As a case study, compared herewith are four basic types of centers all with a rentable area of slightly more than 500,000 square feet. We have assumed that the site varies in shape from the usual rectangular ribbon type to the more nearly square type of the integrated center. They vary from 35.7 acres to 44 acres. The parking index for the ribbon is 6.5 increasing to 8.3 for the two-level integrated center. The centers are at the corner of two major thoroughfares.

The captions on the various sketches and figures give the important factors pertaining to primary and secondary space, lineal feet of frontage visible from the main thoroughfares, the malls or rear, and the like.

Besides the consideration of a prime location on the main street as compared with a secondary location on a side or back street, we must also consider the matter of street-level or entering-level selling space, versus basement or upper floor space. It is quite evident that street-level space is definitely prime as compared with other levels and of course commands a greater rental.

Accordingly one of the primary objectives of a successful shopping center is to create the maximum number of prime locations.

They can be defined as having the maximum amount of pedestrian purchasing power passing per front foot plus having minimum walking distances from car to this front footage.

We have assumed in the case of the ribbon-type centers that a department store key puller will be placed on the end, at A.

The strip plan, Figure I, can only have, so to speak, front and rear parking. Any parking at the ends of the strip would be relatively unimportant. It is obvious that in this plan the important pedestrian contacts between stores have been ignored. It is 1700 feet or about a third of a mile from one end to the other. It is not quite as bad in the U-type and of course is materially improved in the single-level mall type.

It is very much improved, however, in the two-level integrated center. Allowing an additional fifty feet to get from one level to the other by escalators or other means, walking distances between the most widely separated stores would only be 450 feet. This would without any question concentrate a considerable amount of pedestrian traffic in a smaller area, akin to good downtown locations, as demonstrated in all mall-type centers. There are at least three persons per front foot in the mall to one on the outside perimeter.

Referring briefly to the matter of primary and secondary space, in the strip plan, to maintain the total gross area it would be necessary to have over 50 percent of the space in basements or on upper floors, leaving less than 50 percent of prime space at the entering level. This means that a certain amount of selling space would have to be placed in these other-than-entering-level areas. The same condition, of course, would apply to the U, Figure II.

In the two-level integrated center the upper level, so-called rear space, with frontage on the mall and on the side away from the main thoroughfares, would obviously be more difficult to rent regardless of the fact that the mall traffic is the greater. However this area only amounts to 10.4 percent of the total. Fourteen percent of the area is in the basement but this would all be needed for service and stock. Accordingly more than 75 percent of prime space remains.

The method used to determine the average and maximum walking distance from cars to a given store was to divide the parking area up into modules of equal size and figure the direct-route walking

distance from the center of a given module to the closest entrance of a given store. To determine walking spaces under various conditions of usage we considered first the closest 25 percent of parking spaces to a given store, next the closest 50 percent and finally the remaining spaces.

If we can assume that there are sufficient spaces to accommodate fairly well December peaks for shopping goods, there will be many off hours and days when only 25 percent of the parking spaces will be used, many times when only 50 percent will be occupied. However, a key department store in such a center, assuming it might be located in position A (on all plans), could very well generate as much as 50 percent of the total amount of parking. The end location, because it has parking on three sides, provides the greatest amount of parking convenient to the department store—the greatest parking generator.

First, considering 25 percent of the total number of parking spaces nearest to such a department store: we find that in the integrated two-level center, Figure IV, the average distance is 92 feet with none exceeding 160 feet, whereas in the strip center, Figure I, the average distance was 130 feet with a maximum distance up to 250 feet. The integrated center in this case produces a 30 percent reduction in walking distances.

Considering now the closest 50 percent of the parking spaces to store A, the average distance in the integrated center was 156 feet as compared with 414 feet in the strip center. In the latter the maximum distance was 430 feet whereas in the integrated center it does not exceed 280 feet. This is a 62 percent reduction in the average walking distance. In this case we are within our "comfort" standard.

The remaining 50 percent of the spaces farthest away from the department store averaged approximately 700 feet in the U strip and 550 feet in the integrated center, a difference of 150 feet.

A center being designed in Hamilton, Ontario, for the Greater Hamilton Shopping Centre is basically of this two-level integrated type. Also the one in Don Mills Development northeast of Toronto as illustrated in the June issue of the "Architectural Forum" is of this type. Mondawmin in Baltimore, Maryland, is also of the two-level type but without the full features of the roof parking on the lower level. However, careful comparison (by the same method used above) of this with a center of exactly the same design but on a

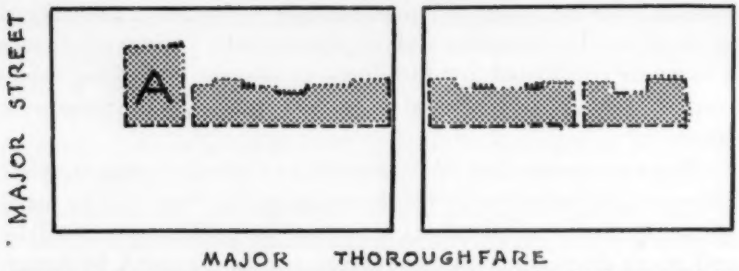



FIGURE 1. Each of these plans has 503,400 square feet of rentable area but the plot areas and the parking indices are typically varied. Figure 1 is a typical strip, has 261,000 square feet of secondary area (in the basement or upper floor). This leaves 48 percent prime space. There are 2,010 lineal feet of main frontage visible from the major streets, approximately 1,000 feet of rear frontage (outside of truck docks) and 550 feet of side street and arcade frontage—a total of 3,560 lineal feet. The plot is 740 feet by 2,100, with 35.7 acres with a ground coverage of 242,400 square feet of buildings. There is space for 3,300 cars in 62-foot wide bins with 9-foot stalls and a parking index of 6.5.

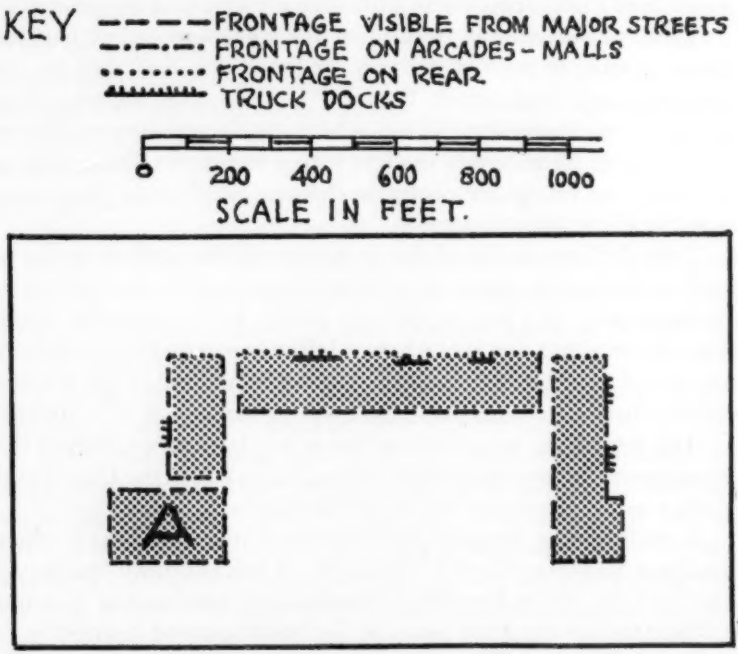



FIGURE 2. This is a typical U strip type having 261,000 square feet of secondary space with 48 percent prime space as in Figure 1. There are 3,000 lineal feet of frontage visible from the main highways, 600 feet in the rear and 750 feet of arcades or a total of 4,350 feet. This is an improvement in pedestrian walking distances over the lineal strip in Figure 1 but the desirable continuous circulation in the parking area is lost, and pedestrian access to all stores still entails considerable walking distances. This plot is 990 feet by 1,700 having 38.5 acres. The ground coverage is 242,400 square feet. There are 3,600 cars with a parking index of 7.1.

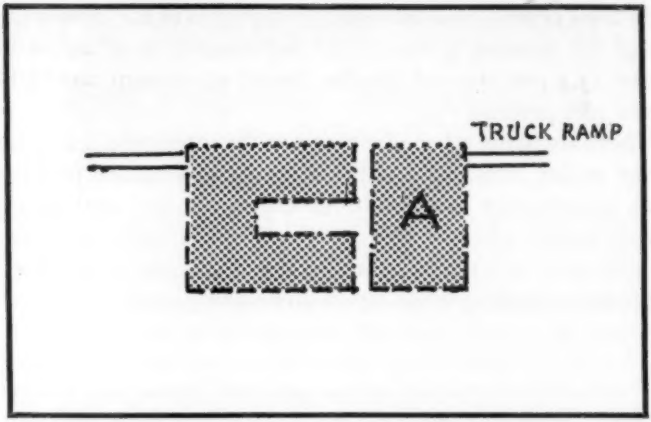



FIGURE 3. This is a compact center of one level of a mall or arcade principle. The parking is equally distributed on all four sides with minimum walking distances as compared with the strip. The interior circulation of both vehicles and pedestrians is good. It is deficient, however, in frontage visible from the highways, with only 1,440 lineal feet. It has 1,240 feet of frontage on the upper level concourse or enclosed mall and another 700 feet on the lower level. The rear frontage is 700 feet, a total of 4,080 feet of pedestrian frontage. The trucking docks would be concealed in an extension of the basement with ramps as access. The plot is 1,220 feet by 1,580, 44 acres. There are 4,000 car spaces with a parking index of 7.9.

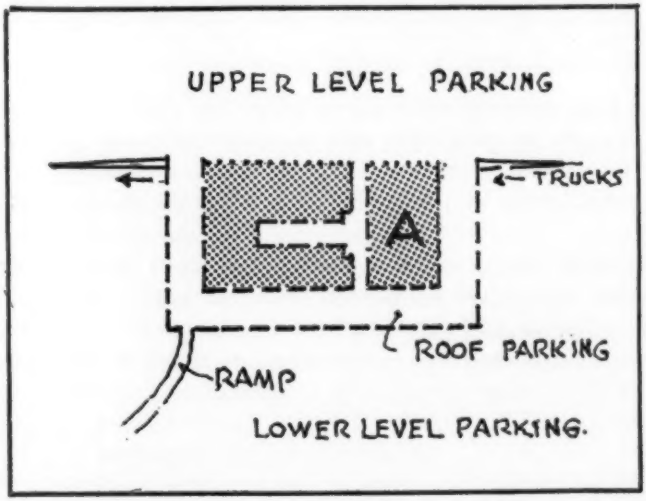



FIGURE 4. This illustrates a completely integrated center with two levels of selling and two levels of parking. It has a total of only 70,400 square feet (14 percent) of secondary space including 30,400 square feet in the basement. This 14 percent of rentable area would be needed for and allocated to service and storage. There are 34,500 square feet on the upper level but with frontage on the concourse in the rear parking area and also approximately 18,000 square feet on the lower level with frontage only on the concourse but with good access.

single level reveals that the walking distances to the closest 50 percent of the parking spaces to the department store would be increased 17.4 percent and for the closest 25 percent would be increased 28.2 percent.

There are many other advantages to the integrated center such as shorter utility runs, materially reduced maintenance problems, a better opportunity to provide for expansion and maintain good parking factors, plus the fact that many of the key departmentized stores or even variety stores can very well use two levels of selling. In this case all selling floors are on an entering level.

# The Sacramento Municipal Off-Street Program

D. JACKSON FAUSTMAN

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SACRAMENTO, the capital of the fastest growing state in the nation, has a metropolitan area population of 265,000 with 157,200 persons residing within the city limits. Per capita automobile registration is probably the highest in the world, one vehicle for every 1.68 persons.

The parking problem in the Sacramento central business district has been critical for years. During the last decade, traffic volumes have increased at the rate of 8 percent a year, while bus riding has decreased annually at a 3 percent rate. These trends shown in Figure 1. Under the pressure of the needs of moving traffic, curb parking space has decreased 10 percent from 1948 to 1954 and still more loss of curb space can be anticipated.

The problem in Sacramento is aggravated further by the lack of permanency of many commercial off-street parking ventures. For example, an inventory of all types of off-street parking spaces in 1939 showed 3,856 spaces, whereas in 1950 there were 3,657 spaces,

a 5 percent decrease. It is evident that private enterprise has not taken the initiative in Sacramento in providing additional off-street parking. Understandably, public pressures developed for the muni-

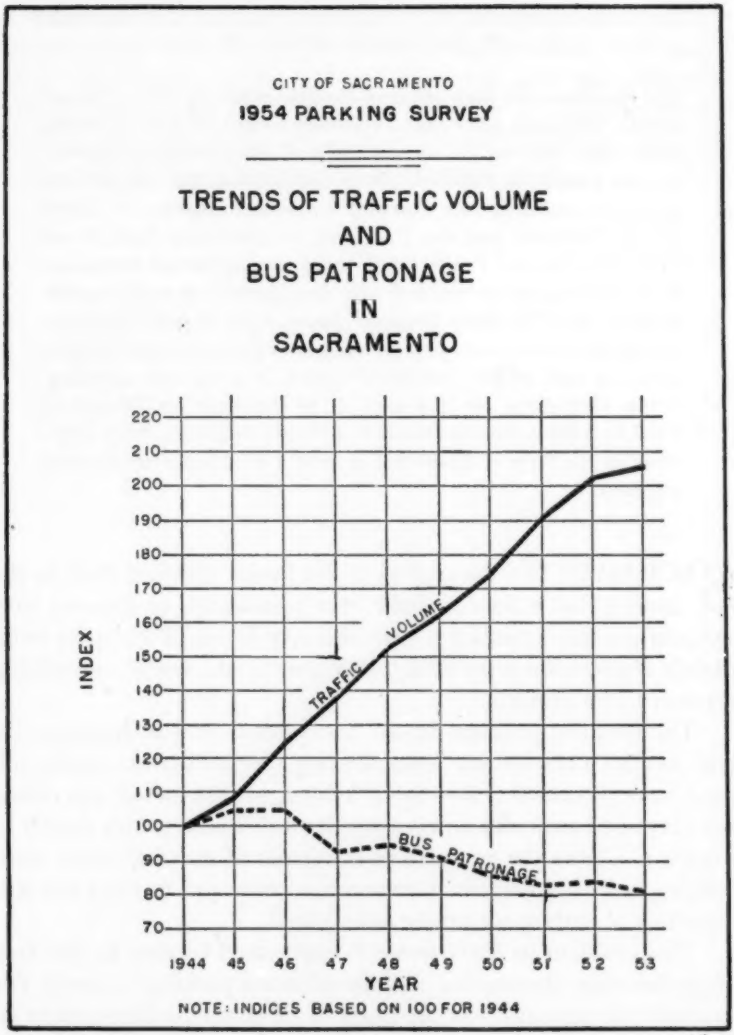


FIGURE 1

cipal government to take positive action in providing more parking space in the central business district.

There is much debate as to the responsibilities of local government versus private enterprise in solving the parking problem. It is submitted that there is no one best answer or method and that the solution can be found in a cooperative approach by the municipality, merchants, and parking facility operators. Such an approach is admittedly difficult at times because some interests can visualize only their particular problem and often lose sight of the overall picture.

Before any community can make real progress in an off-street parking program, several fundamental questions must be resolved:

1. What type of parking should be provided? To accommodate shoppers (short-time parking) or workers (long-time parking)?

2. Who should provide off-street parking facilities and in what proportion? Municipality, merchants, commercial operators?

3. How shall acquisition costs be financed in a municipal program? Pay-as-you-go, bond issues, assessment districts, parking meter funds, etc.?

4. Where and what type of space should be selected? How can the best location be selected consistent with land use, cost, proximity to business frontage, and customer desire?

## Developing the Program

Although parking studies had been made prior to World War II, it was not until 1948 that a citizen's committee on off-street parking was formed to work with the city government. The city council voted to place $50,000 annually from parking meter receipts into a fund for future acquisition of off-street parking facilities. After careful consideration of the questions outlined above, the city council and the citizen's committee recommended an off-street parking revenue bond issue. A charter amendment was approved by the voters in 1948 giving the city power to:

"Acquire, construct, establish, improve, extend, maintain, operate, administer, lease and sub-lease off-street vehicular parking facilities. Issue revenue bonds . . . . . for . . . . . .off-street vehicular parking facilities . . . .

". . . . . allocate 25 percent or $50,000 per annum, whichever sum

is greater, of the net revenues collected from .... parking meters .... for payment of operation and maintenance costs of off-street parking facilities and principal and interest on all revenue bonds issued ...."

During 1948 and 1949, the planning director and traffic engineer collaborated on various technical studies on the characteristics and usage of existing curb and off-street parking. The State Division of Highways broadened their origin and destination survey of the Sacramento metropolitan area to include an estimate of parking demand by location, time, and type. A number of potential sites were selected and appraisals obtained. It is interesting to note in passing, that of the approximately 500,000 vehicle trips per day in the metropolitan area, 40 percent are destined to or from the central business district.

As a result of these studies, three possible sites for off-street parking lots were selected, and an engineering firm was engaged to determine the probable revenues, expenses, and costs of the facilities. Municipal financial consultants of San Francisco then investigated the financial feasibility of the program. They recommended that only two of the three proposed lots be acquired in the initial program, since the estimated revenues from the third lot were not sufficient to amortize its cost.

A $1,600,000 revenue bond issue was marketed in July, 1951 at a net interest rate of 3.192 percent. The proceeds of this issue were used to acquire and improve as parking lots two entire city blocks. The lots were in complete operation by May, 1952. In December, 1953, half of the originally proposed third lot was acquired by the city using the operational surplus from the other two lots and the unexpended balance of the original bond issue. This third lot was placed in operation in June, 1954.

## Marketing Revenue Bonds

Since the use of revenue bond financing for off-street parking facilities is still relatively new, some of the details of a typical issue may be of interest.

As the name implies, revenue bonds are secured solely by revenues from a given source or sources. Their payment is not secured by the power of taxation. As a result, to successfully market an issue

of revenue bonds it is necessary to provide for safeguards which will assure the potential bond buyers that the principal and interest of the bonds will be paid promptly when due.

One of the principal safeguards required is a so-called "coverage." That is, the estimated net revenues pledged to the payment of the bond principal and interest must be in excess of actual requirements. The percentage of coverage required is dependent on the nature of the project and its revenues. For example, a revenue bond secured by revenues of a municipal water system which has a reasonably long earning-record may require no more than a 125 percent coverage or less, while an issue secured by revenues of a project having no operating record, where the revenues must be estimated, may require as much as 200 percent coverage. Obviously, a higher coverage tends to strengthen the security of the bonds and therefore reduces the interest rate at which the bonds can be sold.

Other safeguards or covenants customary in revenue bond financing, and stipulated in the resolution of bond issuance, are as follows:

1. That the issuing entity establish and collect charges and tolls for use of the facilities being financed which, together with any other revenues pledged to bond service, will be equal to at least the minimum coverage as explained above.

2. That the pledged revenues when collected be deposited with a fiscal agent (a bank or trust company) who shall distribute the same to the various funds and make payments on the bonds as provided in the resolution of issuance.

3. That a bond reserve fund equal to about one year's bond service requirements be established and maintained during the life of the bonds to assure prompt payment in the event the necessary revenues are not realized.

4. That the fiscal agent apply the revenues in approximately the following order of priority :

(a) To the bond interest fund;
(b) To the bond principal fund;
(c) To the bond reserve fund (if required);
(d) To the operation and maintenance fund;
(e) To a bond sinking fund;

(f) To a fund which may be used at the option of the city for various purposes.

5. That additional bonds having an equal lien status and secured by the same revenues may be issued only when certain conditions are complied with.

6. That a portion or all of the bonds be subject to call and redemption prior to their respective maturity dates at certain prefixed prices.

7. That proper records of accounts will be maintained and that an annual financial statement applicable to the project be made available each year.

8. That no competitive projects be established by the city that would tend to reduce the revenues pledged to bond service, and that sufficient on-street meters be maintained to produce a designated minimum revenue (if any parking meter proceeds are pledged to bond redemption).

9. That adequate insurance and fidelity bonds applicable to the project and its employees be maintained.

10. That the project will be operated and maintained in an efficient manner, and proper enforcement measures be taken to assure collection of parking charges.

11. That other covenants having to do with events of default, sale or condemnation of property, amendments to the resolution, and other matters be adopted to safeguard the interests of the bondholders.

## Features of Completed Facilities

The three parking lots now in operation are described as follows (see Figure 2 for locations):

| *LOT* | *APPROX. SIZE* | *AREA* | *NO. OF SPACES* |
|---|---|---|---|
| A | 320′ x 340′ | 108,800 Sq. Ft. | 346 |
| B | 320′ x 340′ | 105,600 " " | 358 |
| C | 160′ x 320′ | 48,800 " " | 160 |
| | | | 864 |

It is important that parking facilities be attractive and inviting to potential customers, particularly women. Every effort has been made

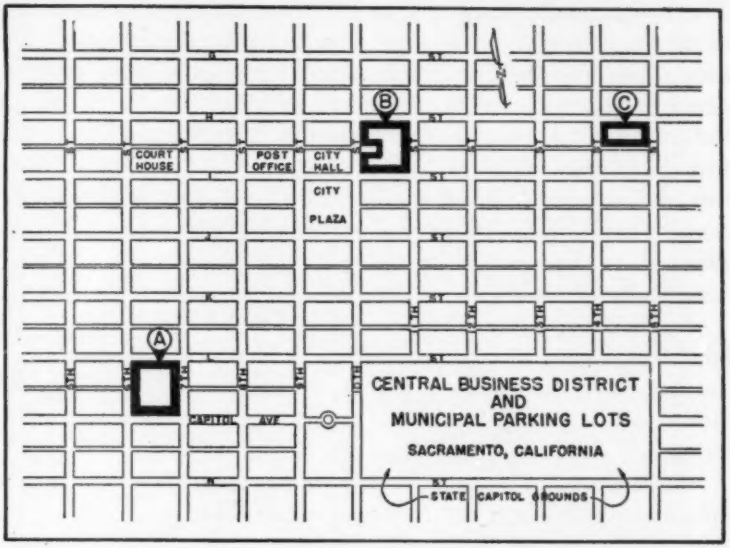


FIGURE 2

to improve the lots to a high standard. The lots are paved with three inches of asphaltic concrete on a six-inch crusher-run base. A complete drainage system is provided for storm water runoff. Mercury vapor luminaires are used for illumination. Perimeter landscaping adds to the general appearance. The cost of the program is tabulated below:

| *Land* | *LOT A* | *LOT B* | *LOT C* | *Program Total* |
|---|---|---|---|---|
| *Improvements* | $604,400 | $624,800 | $202,100 | $1,431,300 |
| Clearing, grading drainage, paving | 32,000 | 32,000 | 20,000 | 84,000 |
| Entrance and exit structures | 11,350 | 11,350 | 1,000 | 23,700 |
| Striping and bumpers | 3,500 | 3,500 | 1,500 | 8,500 |
| Fencing | 1,850 | 1,850 | 1,000 | 4,700 |
| Landscaping | 1,000 | 1,000 | 500 | 2,500 |
| Lighting | 7,600 | 7,600 | 3,000 | 18,200 |
| Total | $661,700 | $682,100 | $229,100 | $1,572,900 |
| Cost car space | $ 1,900 | $ 1,900 | $ 1,430 | $ 1,840 |

The rate schedule on Lots A and B is ten cents per hour for each of the first two hours and fifteen cents per hour thereafter, with no maximum. Evening parking is twenty-five cents. These rates are designed to encourage short-time parking, and operating results indicate that this goal has been achieved. The location of Lot C is such as to cater to all-day parkers and on this basis the rates are forty cents per day or $7 per month with an evening rate of thirty-five cents. There is a heavy demand for evening parking at Lot C because of its close proximity to the Municipal Auditorium and a community playhouse.

It was the recommendation of the financial consultant that the bond issue would be more saleable if the facilities were operated by the city. Accordingly the city traffic engineer was assigned the additional duties of directing and supervising the off-street parking lot operation. A foreman and eleven attendants operate the lots.

On Lots A and B a self-parking plan is used with attendants at the entrance to direct the customer to available space, and at the exit to collect the fee. Because of the large size of the parking areas, it is necessary to have an attendant in an elevated tower to spot the vacancies at those times when the lot is completely filled. Vacancy information is relayed by an intercom system to the attendant at the entrance.

Figure 3 is an aerial photograph of Lot B on which the general layout can be observed. All aisles are for one-way operation and parking stalls are, in general, at a 45-degree angle. Under this system, vehicles flow through the lot from the entrance side to the exits with no conflicting movements. Numbers on the aisles facilitate directing the parkers to lanes containing vacant spaces. Each number is painted a different color to simplify and expedite movements. Figure 4 shows the type of structures used at the entrances and exits.

On Lot C, use is made of non-mechanical parking meters for day-parking, with self-parking under attendant control at nights. An attendant from one of the other lots checks the meters several times during the day. The attendants have special police powers and issue a "demand for payment" to cars in violation.

Merchant validation is accomplished through the sale of tickets or scrip at the regular rate of ten cents. Thus, the merchant gives

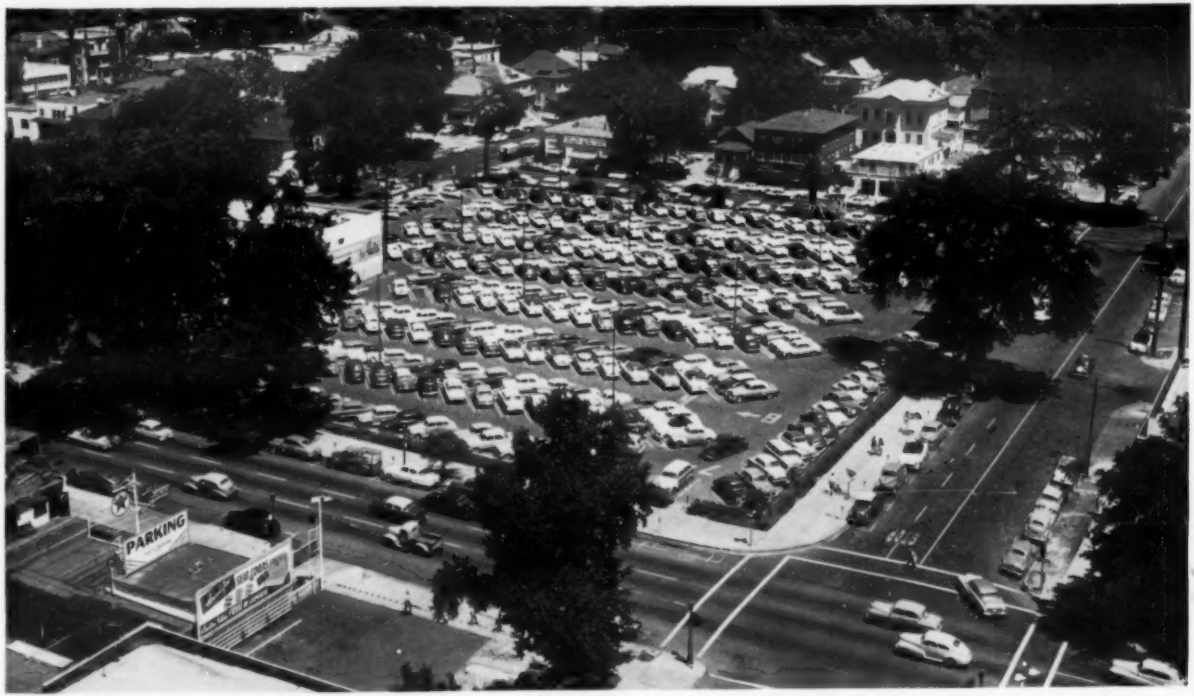


FIGURE 3. Aerial photograph of lot B shows layout of stalls.

FIGURE 4. Type of structures used at entrances and exits for lots A and B.

to the customer parking scrip which is accepted by the parking lot cashier at its face value in lieu of cash. Validations, however, are extremely low and constitute less than 4 percent of the total business.

### Financial Statistics Show Surplus

The use of the facilities has exceeded the predictions made by the revenue forecast. The following tabulation shows the financial statistics of the first two full fiscal years of operation of Lots A and B combined. Lot C did not start operation until June, 1954 and hence is not shown.

| | *1952–53* | *1953–54* |
|---|---|---|
| *Operating Revenues* | | |
| Parking fees | $163,750 | $175,500 |
| Interest on investments | 1,980 | 1,980 |
| Pay telephone, etc. | 281 | 300 |
| Subtotal | $166,011 | $177,780 |
| *Operating Expenses* | | |
| Salaries and wages | $ 42,563 | $ 46,297 |
| Repairs, Mantenance, Utilities | 4,378 | 6,075 |
| Tickets and miscellaneous supply | 872 | 1,950 |
| Subtotal | $ 47,813 | $ 54,322 |
| *Net Operating Revenue* | $118,198 | $123,458 |
| *Debt Requirements* | | |
| Interest | $ 51,242 | $ 49,200 |
| Principal payment | | |
| Fixed maturity | 15,000 | 15,000 |
| Sinking fund* (minimum) | 10,000 | 10,000 |
| Subtotal | $ 76,242 | $ 74,200 |
| *Net Operating Profit* | $ 41,956 | $ 49,258 |
| *Pledged Parking Meters Revenue* | 50,000 | 50,000 |
| *Net Profit and Other Income* | $ 91,956 | $ 99,258 |
| *To Sinking Fund* (for accelerated bond redemption) | $ 39,268 | $ 44,629 |
| *To Surplus* | $ 52,688 | $ 54,629 |

* For bonds called and redeemed prior to maturity.

Under the terms of the bond issue, surplus revenues may be used only for additional parking facilities, improvements to existing facilities, or acceleration of the bond redemption payments. The surplus to date has been used in acquiring Lot C. No policy decisions have been made as yet by the city council on how to use future surplus funds.

## Operating Characteristics

In the approximately two and a half years the lots have been in operation, over 1,600,000, vehicles have been parked. This use represents an overall space turnover of about 3.3 per day. Experience indicates that a daily turnover of four is the maximum to be obtained under existing conditions of street traffic flow. Parking demand during December is such that patrons wait in a line three blocks long, knowing that, because of the continuing turnover in the lots, they will be able to park in a matter of minutes. In other words, a turnover of four taxes the adequacy of the street system to reservoir the waiting vehicles and is also a measure of the practical capacity of the facilities under present average parking duration.

Monthly variations in parking are shown plotted against depart-

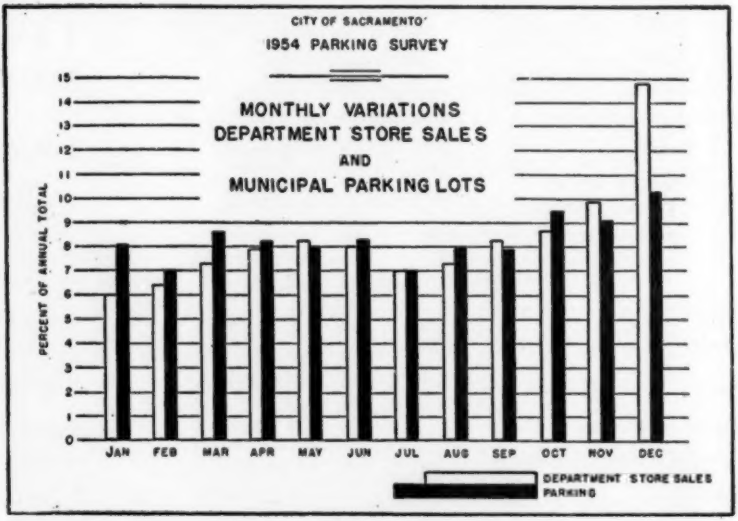


FIGURE 5

ment store sales in Figure 5. It is interesting to note the close relationship between parking and sales activity. This economic re-

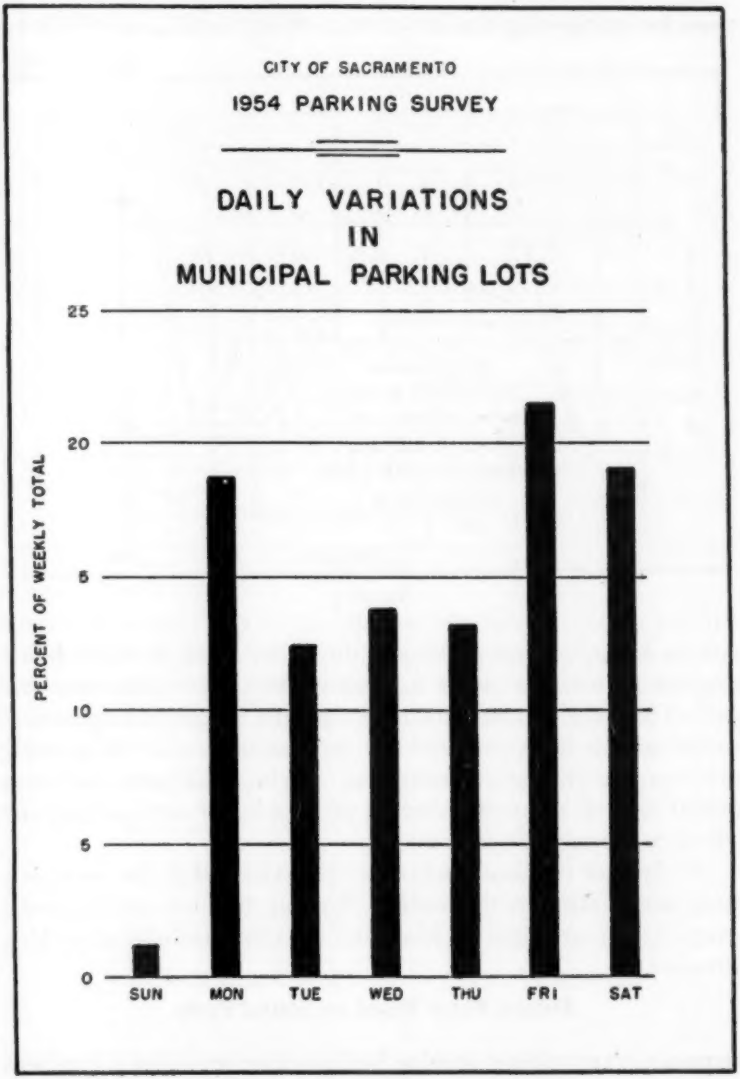


FIGURE 6

lationship probably underlies the data shown in Figure 6, the daily variations in parking activity.

Hourly variation is shown in Figure 7. These data point up the need for recognizing the importance of high arrival and discharge

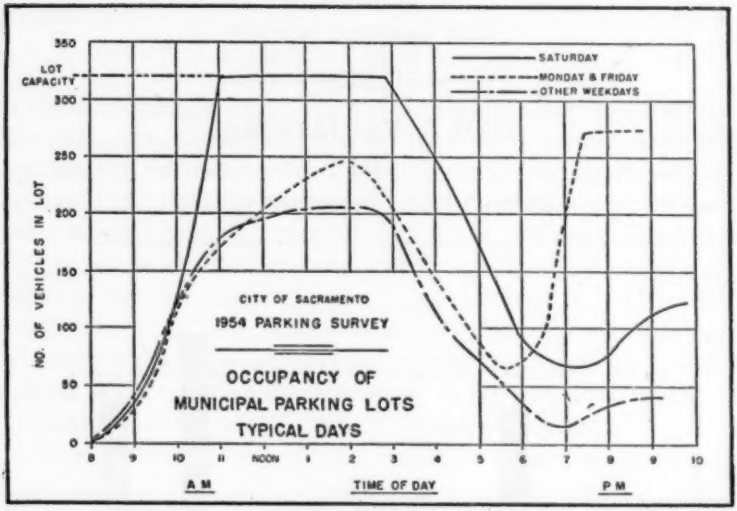


FIGURE 7

rates in designing large parking facilities. For example, in the morning peak between 10 and 11 A.M, more than 300 vehicles enter and park. Thus, the entrance layout, attendants, etc. must be geared to an arrival rate of five vehicles per minute, otherwise the abutting street system will become congested. During peak hours and days, special controls are used including prohibition of curb parking and left turns across traffic into the lot.

Analysis of the time parked per car reveals that the mean is 2 hours and 10 minutes, the median 1 hour 45 minutes, and the modal grouping 1 hour. Figure 8 illustrates the characteristics of parking duration.

## Future Plans Based on Sound Facts

Sacramento's municipal parking facilities have provided the nucleus for developing a long-range, cooperative off-street parking program

in which both the city and private enterprise can assume certain responsibilities. Work is now underway on a city-wide parking survey analyzing parking conditions in all outlying business centers, as well as reevaluating parking conditions in the central business

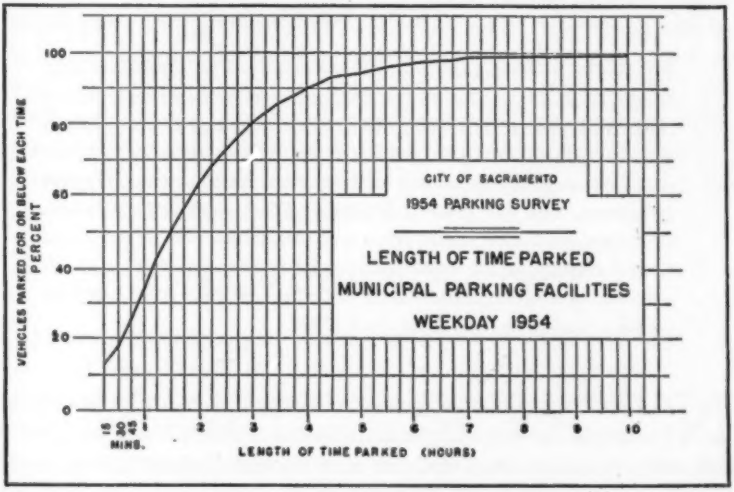


FIGURE 8

district. The study will include the preparation of a master parking plan for orderly development of off-street facilities. Sacramento has not solved its parking problem because better facilities attract more parkers, creating more shortages, and so on ad infinitum. However, it has again been demonstrated that concerted community action on a program based upon sound facts does provide parking space.

# Protecting Good Neighborhoods From Through-Traffic Decline

SCOTT BAGBY

*Mr. Bagby is city planning director-consultant for Grand Rapids, Michigan and a partner in the firm of Bagby and Catlin of Montclair, New Jersey. Beginning twenty-five years ago as a draftsman for the Ohio Planning Commission, Mr. Bagby has since 1942 engaged in consultant-planning with Howard Bartholomew, Weaver Pangburn, and his present associate, Scott Catlin, for Kansas, Michigan, and New Jersey cities and townships. Mr. Bagby chose Grand Rapids as his home because he wanted to prove that all portions of a metropolitan area had much to gain from working together instead of opposing each other.*

NO CITY can afford to let its existing good, sound home-neighborhoods decline. Three actual cases of doing something about this vital problem in a positive way should interest everyone interested in traffic and city planning.

The first case involved an Upper Montclair, New Jersey neighborhood, where the basic problem was by-pass traffic that should have been carried on the adjoining major streets. The second case was a simple street change in Grand Rapids, Michigan, which preserved the value of several hundred homes. The third was united action in Grand Rapids by seven hundred families with industrialists adjacent to their neighborhood in a large-scale, comprehensive neighborhood conservation plan.

It must be emphasized at this point that the whole idea of neighborhood protection from through-traffic must be prefaced with an adequate major street plan capable of carrying not only today's traffic but of carrying major increases in the future. Adequate street plans require complete coordination between traffic engineering and city planning staffs.

It must also be emphasized that these changes were made as part of a careful planning program which fully recognized some basic city development factors not yet too widely recognized. This back-

ground must be understood if similar neighborhood conservation actions are contemplated in other communities.

Usually things grow and change through a process known as evolution. If we just think of the major changes caused by the automobile, the airplane, new methods of taxation and city financing, the complete change in residential development patterns caused by FHA, and changes in industrial development patterns caused by a combination of all of these factors, it is pretty obvious that city development since 1920 has changed so rapidly that we must think in terms of revolution instead. In many cases the accepted ideas and procedures on city development in the 1920 period are the worst things a modern community could do.

## Changes in Planning Since 1920

This revolution has made itself felt in the planning of new neighborhoods. It took a little time, but the 1920-style subdivision idea of "every street a through-street" has almost completely disappeared as the bad effects of unnecessary through-traffic in home neighborhoods have been proved. With few exceptions every good new subdivision in the country is designing protection into each newly developed neighborhood. This means, of course, that the better designed each new subdivision is, the more competition these new neighborhoods offer for the built-up, existing neighborhoods in American cities.

At this point we must recognize that this problem is the crux of the two worst problems all American cities are facing:

1. The spreading cancer of blight, devouring and devaluing block after block of older existing city neighborhoods.

2. The suburban sprawl problem of new small-lot subdivisions locating in wastefully scattered areas which will cost three or four times as much when they are furnished the city-type services they will require.

The subsidy being poured into these two problems is the biggest tax-waste in America today. This waste is becoming increasingly worse all the time. This may come as a shock to those who believe that traffic and parking are the major American city problems but

if we really dig down into what makes a city tick we find we could afford to solve every traffic and parking problem and have money to spare if we could save the money we are wasting on these subsidies to urban blight and suburban sprawl.

In developing a sound planning program it is obvious that through proper zoning and subdivision control we can pretty well insure that new neighborhoods will be designed to maintain their livability and value. It is obvious that some residential areas are so far gone that they will have to be rebuilt completely through use of redevelopment laws. In most cities this leaves, in between these two extremes, the greatest portion of the housing of the community. The values of these still-good homes can only go one way—down—if we just sit complacently by and hope for the best.

### Preventing Decline Is Major Problem

If we really analyze this problem we see that even if every city could start tomorrow on a complete redevelopment program for all of its worst areas, by the time such a program were accomplished a larger surrounding band of existing "next-worst" areas would have declined to blight and slum areas, and an even bigger redevelopment job would be in store for the future. Following this line of reasoning, it becomes even more important to prevent the decline of existing still-good neighborhoods than it does to rebuild the poorest ones, though any sound planning program would hope to do both jobs.

This leads to more careful study of the all too commonly accepted axiom that as a house grows older it is bound to decline in value. Like so many other accepted cliches this is not necessarily true at all. Hundreds of neighborhoods thirty to forty years old are more valuable now than they ever have been. Thousands of twenty-five-year-old neighborhoods have become blighted problem areas. The reason so many neighborhoods have declined about equally with age has been not the age-factor but lack of protection and lack of necessary services.

Now that we are thinking in these terms it is possible to study the many other problems besides the mere age of buildings in the areas which have gone down. It is possible to analyze the assets that have kept some much older neighborhoods desirable and livable.

From such studies it is easy to show a definite relationship to the amount of protection or lack of protection afforded home neighborhoods through

positive zoning,
adequate parks,
adequate schools,
good utilities and services,
good police and fire protection,
reasonable tax charges,
accessibility of the neighborhood to good highway connections, and protection from traffic hazards within the neighborhood itself.

Few accepted present home-neighborhoods have all of these factors, but the more of these a neighborhood has the more likely it will be to maintain its attractiveness and economic value.

The Montclair Planning Board had adopted a major street plan as part of its over-all planning program. This street plan called for using a few key streets to adequately handle its present and potential traffic flow, and rigid protection on all other streets from anything but neighborhod traffic. Two of these major streets adjoined the south and west edges of the Fieldstone neighborhood in Upper Montclair. This neighborhood had troubles. It had been started in the 1920 period as a high-type deed-restricted subdivision when a curving street connecting the two major streets through the middle of the subdivision had been considered good design. In actual practice it worked out that the curving street was a wonderfully convenient by-pass for most of the heavy traffic which should have stayed on the major streets. This street was also a convenient walk-way between the busline and a swimming pool north of the city, and because of these problems about half of the subdivision had remained undeveloped.

### Montclair's 1949 Action to Save Values

At a neighborhood meeting about some of these problems the planning board's program of complete positive neighborhood protection and conservation was brought up. It was quite a shock to the group

to think of removing portions of the existing thirty-foot concrete street to redesign the area into a protected home-neighborhood. Everyone there had seen and appreciated the protective design of the good new neighborhoods but it simply had not occurred to any of them that existing patterns might be changed. Immediate objections were raised as to fire protection and other related service problems. It was decided further meetings would be held. The planning staff drew up sketches of what might be done.

From the start it was pointed out to the neighborhood that this was basically their problem. It was their homes which would be devalued and their children who would be endangered by a continuation of existing conditions. The cost of any changes would have to

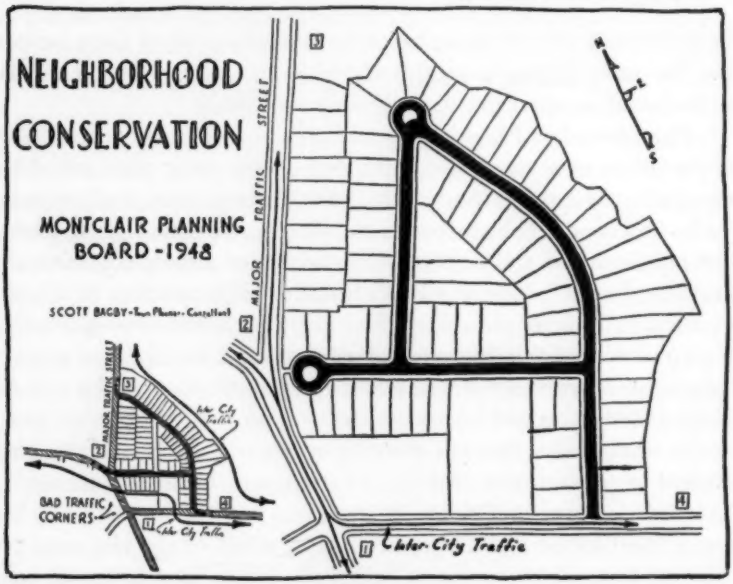


FIGURE 1

be met by the neighborhood on a special assessment basis just the same as if the entire neighborhood were petitioning for improvement of the streets instead of revision of the streets.

After about a year of discussions and meetings all fears had been allayed and all questions had been answered. As far as services were concerned the area with the street changes would be just as accessible

as any existing area two blocks farther away. It was pointed out that this "moving two blocks farther away" was much sounder than letting the neighborhood decay and moving miles farther out into a protected, newer neighborhood after the decay occurred. The town officials needed a little selling too, as this was quite new and quite drastic. One of the major property owners in the neighborhood was a progressive builder who had acquired most of the vacant land. He stood to be assessed the heaviest amount, since the assessments were to be paid by the lot. He stated at the neighborhood meeting that if the neighborhood wished to add this protection he would go along because he was sure his lot values would be improved by more than the assessed amount.

The changes were made in 1949. It cost approximately $10,000 to remove portions of two pavements, to construct two adequate turnaround circles and to change utility and drainage structures. Today every lot in the neighborhood is developed with a better-than-average type home. Every property in the neighborhood is more valuable. Failure to act in 1949 would have resulted in much lower values by now and particularly in much lower values ten or twenty years from now.

### Protecting Neighborhoods in Grand Rapids

The new area planning program worked out for the Grand Rapids, Michigan area also called for a modern major street plan as one of its basic parts. This plan was based on the principle of using a few streets to carry traffic and protect the many remaining streets for neighborhood use. Grand Rapids is a solidly conservative community, and even in 1950 had very few examples of good, protected new subdivisions designed. Practically every portion of the metropolitan area was laid out in rectangular blocks, with every street a through-street. On top of this, many of the 1920 subdivisions had provided diagonal streets coming into main intersections, resulting in some six-and-eight point intersections.

One of these diagonal intersections was located at the southeast corner of Alger and Madison, two major streets. A fine neighborhood had developed in this area, but it was obvious that if this diagonal street was ever developed through a large parcel of vacant

property it would become the traffic by-pass route for major volumes of passenger and truck traffic. Meetings were held with this Mulford Drive neighborhood with the idea of closing off the street at the intersection to make future traffic diversion impossible. Since the street did not go through the undeveloped property to the east and not enough families in the area could picture the seriousness of what would happen when the street was opened in the future, no action was taken.

In 1951 the large undeveloped property was ready for subdivision. This subdivision called for completing the through-bypass street. There was little chance of changing Mulford Drive since it existed on both sides of the vacant property. The planning staff, working with the developers, pointed out that the new subdivision would also be more valuable if protected from this by-pass movement and obtained the cooperation of the developers in designing a modern street diversion at the intersection of Mulford Drive and Linden Avenue.

Traffic, of course, had never had the experience of going all the way through Mulford Drive because this property had been vacant. The first time it could be driven through, a street change had been made so that traffic was diverted out of its by-pass line of direction from the first moment the area was opened to traffic. As a result, the certain devaluation of all existing homes and the more rapid depreciation in the new subdivision itself had been completely avoided.

### Plan in Operation Visualizes Benefits

This actual demonstration in operation was most helpful in carrying out the later first large-scale neighborhood conservation. The planning staff had been working with the entire 700-home Dickinson Area for some time. This neighborhood was surrounded by major streets to the east, south and west and by a growing heavy industrial district to the north. Two of its east-west streets and one north-south street were short-cut by-pass routes for both automobiles and trucks.

Neighborhood action began with a small meeting called because of a problem from expansion of one of the industrial properties. The planning staff pointed out the existence of many common problems and the possibility of meeting all of them through united neigh-

borhood action. It was obvious to every owner that he would have to decide either now or in a few years to sell his home at a loss and move farther out to a better protected area if existing conditions continued. It was also obvious, on the other hand, that the area was

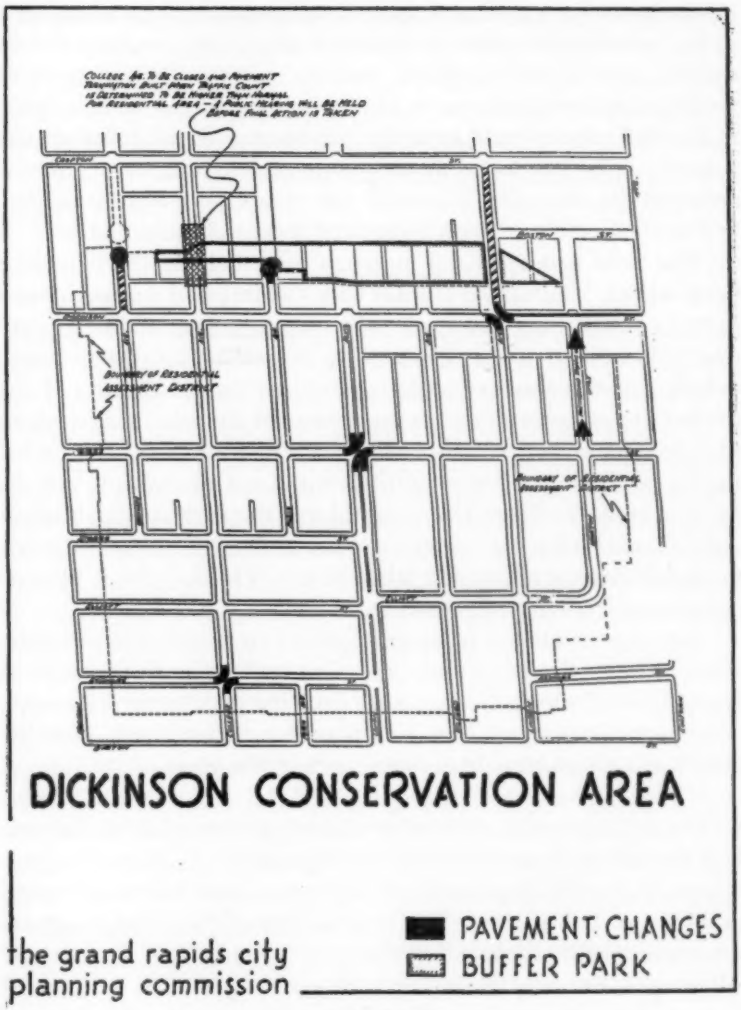


FIGURE 2

well located, with basically modest but sound housing which was deteriorating only because of lack of protection.

The planning staff prepared several plans of what might be done through united neighborhood action. It was suggested that the ever-present threat of further expansion of industry through zone changes be countered by a dedicated strip of buffer park, which would provide a permanent separation between the living area and the industrial area. It was suggested that the existing street pattern, so attractive and conducive to by-pass traffic movements, be redesigned so that the streets would serve the neighborhood but definitely discourage any by-pass traffic. It was pointed out to both the residential area and the adjoining industrial area that Grand Rapids needed, and needed to protect, both residential areas and industrial areas.

The final neighborhood meetings were held in the neighborhood school. The Grand Rapids City Commission was petitioned to make the changes and assess the entire neighborhood in proportion to benefits received. Twenty-five industrial firms to the north voluntarily raised and contributed $20,000 toward the cost of the project. It was important to set a precedent of city-wide participation in this type of action, since many other neighborhoods needed similar protection and most of them would not be as able to pay the full cost as this area was. It was agreed that the park and its development should be the city's share since the area needed a park whether the neighborhood action was taken or not. This left about $40,000 to be raised from the neighborhood to finance the entire job.

Assessments ranged from $100 per lot in the area most immediately adjacent to industrial expansion and the buffer park, to as low as $20 in the areas farthest away from the park or street changes. The special assessments, like assessments for paving or any other improvement, could be paid in one year or in five years.

The plate shows the changes proposed. All but two of the changes are in operation today. Lest other communities receive the impression that all has been sweetness and light through this entire procedure, it should be pointed out that there have been interesting problems as well as interesting results. One of the worst problems was occasioned by the fact that the project was ordered done in the fall of 1952, but only the buffer park was completed by summer of 1953, and when the street diversions were made in the fall and

winter months it was too late to put in the landscaping, which is an important part of the street diversions.

There were minor complications such as a delay in erection of street signs. A completely unforeseen problem came from motorists and drivers of delivery trucks accustomed to using the streets for convenient short cuts who looked upon the street diversions as an infringement of their rights and actually drove over the curbs and through people's yards to continue their accustomed route. This, of course, had not been a problem in the Mulford Drive case, since no one was previously accustomed to taking that route. Stronger police enforcement at the early stages will be necessary any time such changes are made.

### Program Offers Chart for Other Cities

The Grand Rapids Planning Commission is now working with a second entire neighborhood. It is most helpful to be able to have an actual example where people can drive over and see what can be done rather than leave future changes to their imaginations.

At this point it would be well to review the original statement that no city can afford to let its existing good, sound home-neighborhoods decline. A long-range look at permitting such decline can only lead to pessimistic prospects of planning to abandon 80 percent of most of our built-up cities. A modern planning program worthy of the name must recognize that this is the key problem and use all planning details to solve the basic problem.

Grand Rapids can demonstrate a course of action for any other American city. Its new zoning ordinance adopted as part of this approach offers positive protection to homes, to business and to industry. Major expenditures for parks and park-schools have been made as investments in sound, necessary services to preserve home values rather than as fancy frills. The entire new school program is based on adequate school services for every neighborhood, in locations which, under the planned policy of park-schools, provide neighborhood parks on the same property. The policy of city participation with any neighborhood for planned protection of home values has been firmly established.

In any community there will be thousands of people who can

prove conclusively that nothing can be done about anything. What we need more than anything else are ways to show that necessary things can be done. There are answers to every objection that will be brought up.

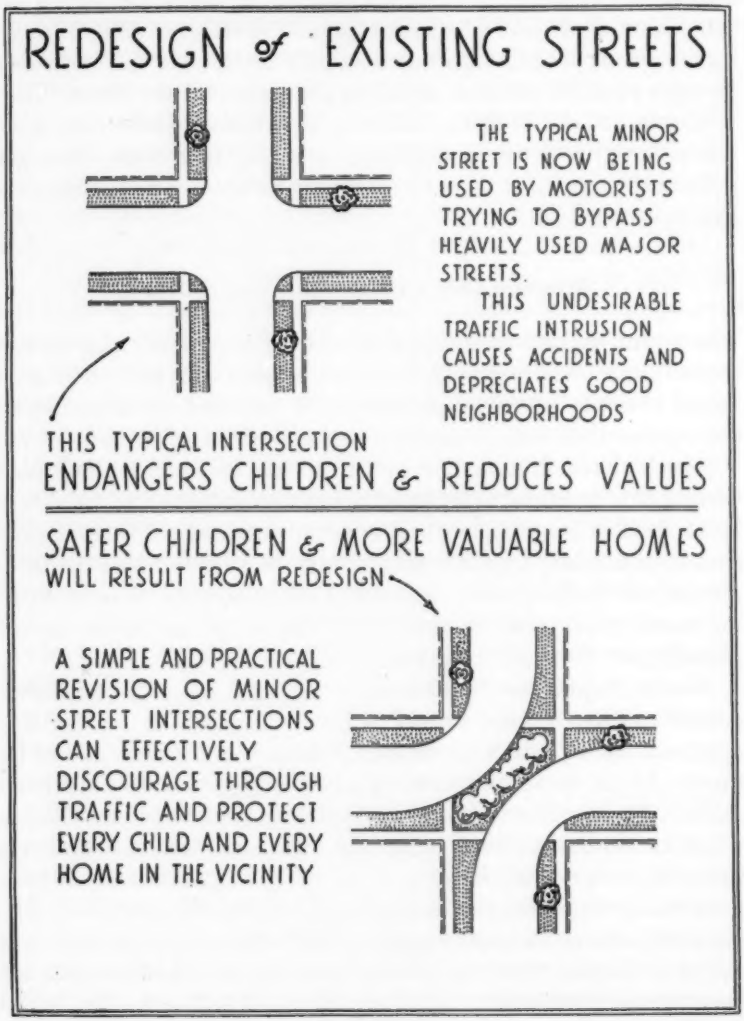
REDESIGN of EXISTING STREETS
THE TYPICAL MINOR STREET IS NOW BEING USED BY MOTORISTS TRYING TO BYPASS HEAVILY USED MAJOR STREETS.
THIS UNDESIRABLE TRAFFIC INTRUSION CAUSES ACCIDENTS AND DEPRECIATES GOOD NEIGHBORHOODS
THIS TYPICAL INTERSECTION
ENDANGERS CHILDREN & REDUCES VALUES
SAFER CHILDREN & MORE VALUABLE HOMES
WILL RESULT FROM REDESIGN
A SIMPLE AND PRACTICAL REVISION OF MINOR STREET INTERSECTIONS CAN EFFECTIVELY DISCOURAGE THROUGH TRAFFIC AND PROTECT EVERY CHILD AND EVERY HOME IN THE VICINITY

FIGURE 3

Many people studying this problem of older neighborhoods believe that even if major new protections and services were given to existing neighborhoods it would still be a losing battle. They have reckoned without one of the strongest new forces which will be affecting American cities for the next ten or fifteen years. This factor is the direct relationship between age distribution and housing demand. The peak births of 1919 to 1928 caused a peak group of 20-to-30-year-old people from 1944 through 1953. This group was responsible for the tremendous increase in marriages and new births, and also was responsible for the tremendous demand for small-unit housing accommodations. As the depression-year babies enter this age group this demand will slacken and reach a low point by 1959, when this age group is composed entirely of depression babies.

Taking this one step further, we must recognize that this large, important age group is now changing over and becoming our 30-to-40-year age group. This will bring about the greatest demand we have ever had for three-and-four-bedroom housing units right at a time when the cost of larger new houses is excessively high and the cost of wastefully located new streets, utilities, schools and services in suburban areas at today's high prices is requiring higher tax charges out in the suburban fringe area than are necessary in the already-served central city areas.

One demonstration is worth thousands of words. The Grand Rapids Dickinson Conservation Area can be an important demonstration to every traffic or planning technician in every type of community. Increasingly, this kind of partnership action between the city and one of its neighborhoods, which neither could do alone, is an important precedent for every property owner in the country. These neighborhood changes could never be superimposed upon a neighborhod . . . . they must come from the grass roots of the neighborhoods themselves and be paid for largely by the neighborhood itself. The job of the community and the city official is to combine the small amount of original idea, necessary policy and necessary city action with the large amount of neighborhood responsibility and investment which can place the plan in action.

Traffic solutions as part of a truly coordinated overall planning program can play a major role in insuring that cities go forward in the future. Expediency planning to handle traffic by opening up

more and more residential streets to excessive traffic volumes will insure that the city in which this is being done goes backward. Cities change rapidly. Cities do not stand still. Your community must begin to make its choice of going forward or backward very soon. Your community is your children, your families, your home, your businesses. They can be safer, better served, better protected than they are. Traffic planning as an integral part of overall planning can be a major two-way tool for positive community action.

# Regional Studies for Business Men

FREDERICK H. ALLEN

*Mr. Allen is president of Harrison, Ballard and Allen, Inc. Organized in 1946 the firm specialized in large-scale housing of all types and has designed 90 million dollars' worth from Connecticut to Virginia. A leading consultant firm in urban redevelopment, city planning, and slum clearance, it currently has contracts with ten cities in that field. "Plan for Rezoning New York City, 1950," now completed, was the company's most important assignment. Mr. Allen, a graduate architect and formerly a mortgage officer with the Bowery Savings Bank, is the author of "Your Mortgage (1950, Duell, Sloan and Pearce) a handbook for home buyers, and of "New York City in relation to Real Estate" (1942, published by five lending institutions).*

LAST summer the president of a large restaurant chain in New York City asked us where the best "automobile locations" would be in the region for future development. The secondary question was, "Should we go into large shopping centers?"

A study of the chain's operations revealed that its market consisted of three large groups of customers: the family seeking a wholesome dinner; the daytime worker or shopper looking for a wholesome lunch; the counter and "take-out" clientele. It cost about as much to serve lunch as it did dinner but the dinner check was almost twice as large. This immediately emphasized the need for a location which would attract around-the-clock customers so that the three functions of the chain would receive their full opportunity for maximum sales.

Having a quality name and generally catering to upper income families, the restaurant chain faced the problem of seeking the concentrations of such families in the fourteen counties surrounding New York City in three states.

New York City has been losing 60,000 persons each year in the middle and upper income bracket. This "carriage trade" is the market the restaurant chain has been losing. The essence of the problem is to locate and recapture this market now residing in the fourteen counties adjacent to the city.

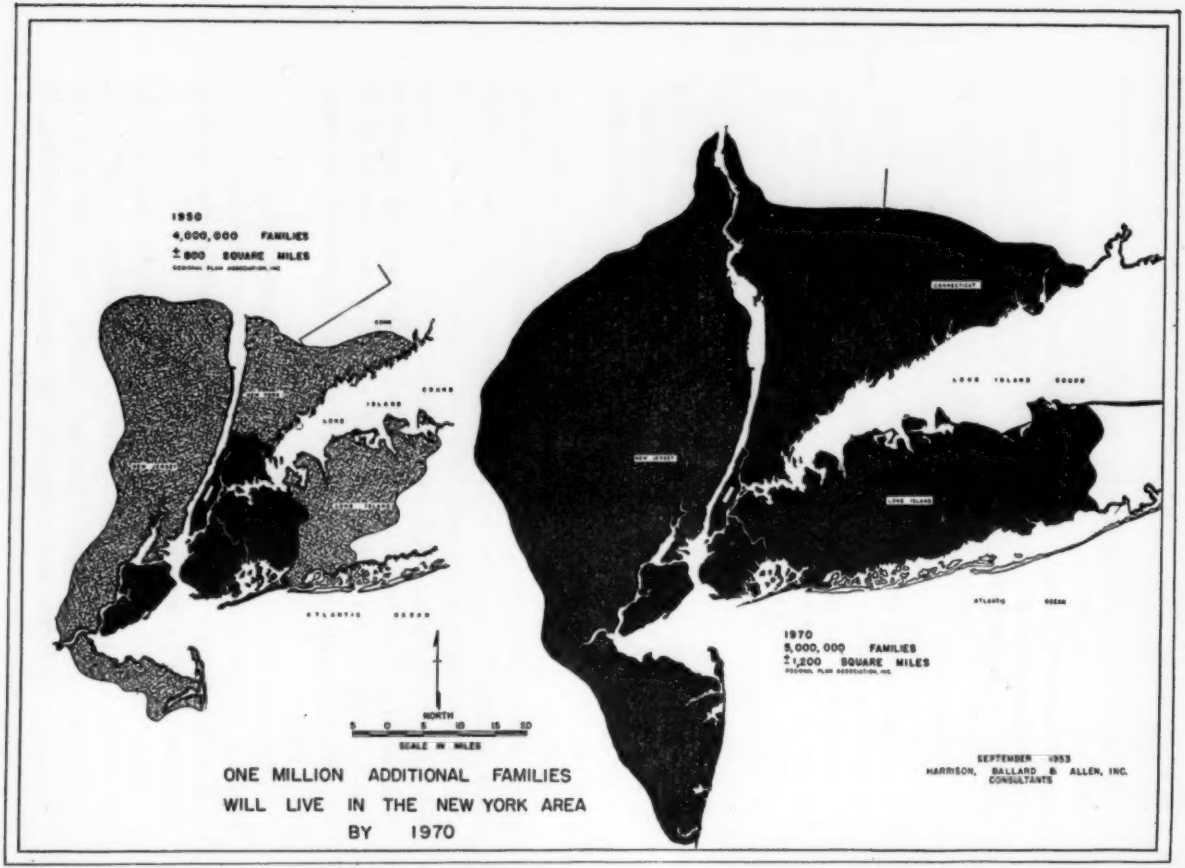


FIGURE 1. The region will increase in area by 50 percent for a 25 percent increase in population.

Within such demonstrable markets, however, the prime requisite was *accessibility*. The next factor in our survey was a search for double market, that is, a daytime market of business and shopping combined with an evening and weekend market of family business on wheels.

### Eight Questions Answered by Study

Accessibility is not an easy thing to show a layman. It is easy, for instance, for a business man to be impressed with proximity to a thruway, a parkway, or a heavily traveled turnpike. One of the new shopping centers in the New York region has been promoted largely on the basis of a huge auto count estimated for the new State Thruway. That there was only access and egress from one side and that the bulk of traffic would be going by the door at 60 miles an hour did not occur to some of the commercial men interested.

Even an ordinary road map does not show true accessibility to the untrained layman. We have found it important to interpolate on our own graphic presentations the real variations in quality and capacity and we eliminate all minor roads which clutter up the usual map. A quick picture needing no study to understand it is a prerequisite to our reports to clients.

The restaurant study brought out some extremely interesting variations in the New York region and formed the basis for area recommendations some of which contradicted generalizations of the management. The metropolitan area is so vast that few men in top management positions have anything more than a sketchy notion of what is happening in this complex of 15 million people. Our first job was (indeed the first job of all consultants should be) to show management what *was* happening in the 800 square miles we were studying. Here were some of the questions answered:

1. If our market is the family with $5,000 and over to spend, where is it concentrated; where do these people live and in what numbers?

2. Where are the greatest concentrations of new families; those coming from outside the region and those leaving the city for the region?

3. How much is spent in the different counties on eating out, packaged liquor, total retail, automobile?

FIGURE 1. The region will increase in area by 50 percent for a 25 percent increase in population.

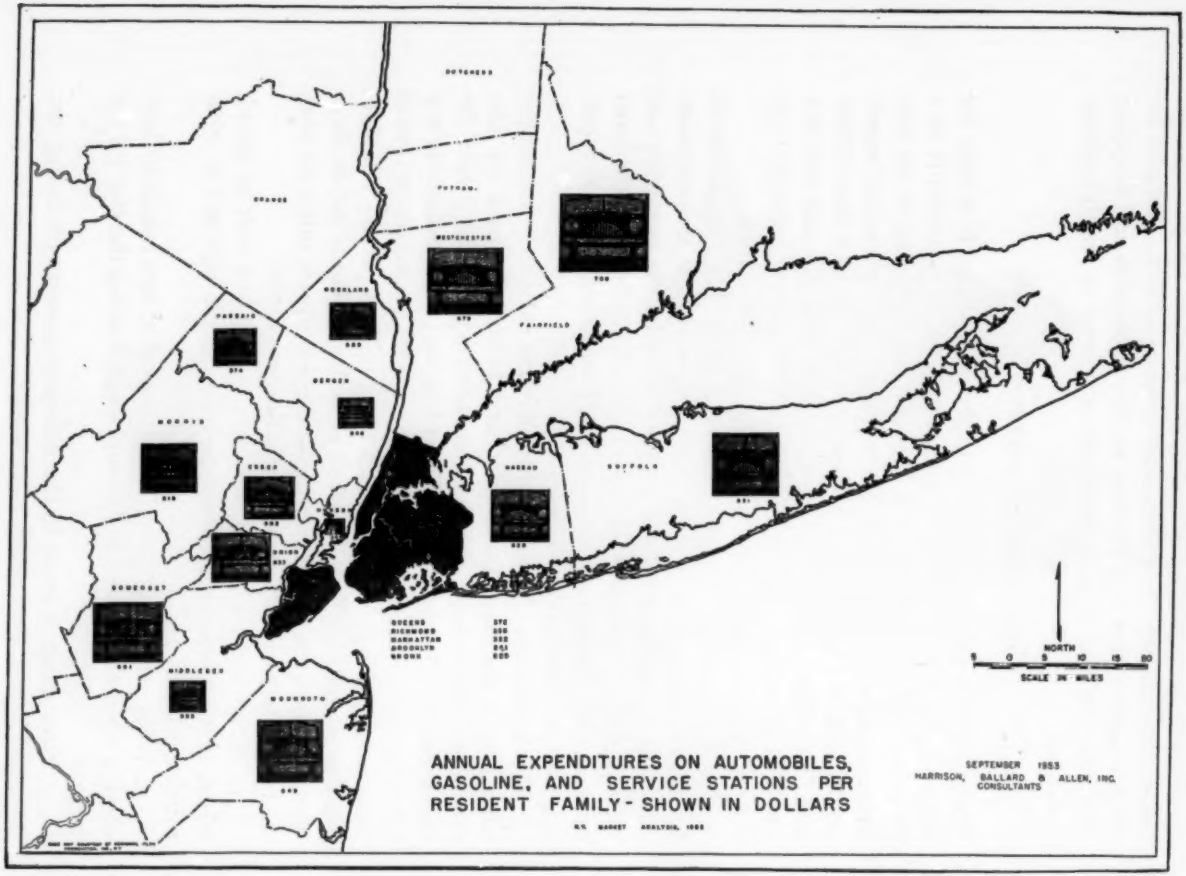


FIGURE 2. The highest proportion of two-car families occurs in Westchester and Fairfield counties. Expenses in Monmouth and Suffolk counties are inflated by summer trade.

4. Apartment dwellers being food customers for restaurants, where are the concentrations of apartments in the region?

5. Where is the real center of gravity of population in each big natural market area?

6. Where are today's greatest concentrations of retail sales, by community?

7. Where have big-name department and chain stores located branches in the region and where are they currently planning to go?

8. Where is the client's competition located?

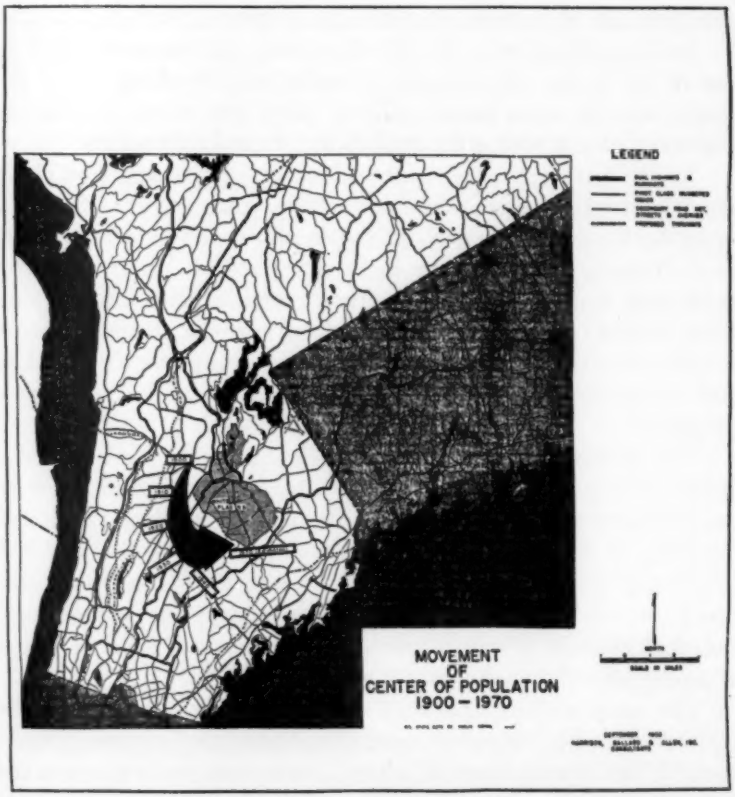


FIGURE 3. The location of the center of population and its movement are important in determining the commercial location designed to draw from all parts of the market.

FIGURE 2. The highest proportion of two-car families occurs in Westchester and Fairfield counties. Expenses in Monmouth and Suffolk counties are inflated by summer trade.

These eight questions were answered graphically and, in each case, against a highway pattern showing related accessibility. Were all the maps made on transparent material and superimposed, the answers to the best locations for the client would have been readily apparent. Even with separate illustrations, the conclusions virtually jump at the reader.

### Facts Revealed in 18 Maps

Some of the facts brought out in the eighteen maps we prepared for our client are of possible interest to the reader:

Packaged liquor sales are directly related, but inversely, to eating out of the home. The amount of eating and drinking out of the home depends upon local tradition, racial and ethnic population characteristics, as well as the availability of good restaurants.

In the fastest growing county, Nassau, department and chain stores have followed population growth to a reasonable degree since 1942. In Bergen County, N. J., the second fastest growing county in the region, the same stores had not moved out—in fact, are just beginning to do so. Although Bergen's families have less to spend than Nassau's we believe that the sharp contrast in branch store development is due as largely to the lack of competent factual data and comparisons as it is to Nassau's competency in real estate promotion.

The layman business man has a tendency to think of retail activity being concentrated in the stores he happens to know of personally or stores with the most prominent advertising. The actual intensity of retail activity when presented graphically is often surprising. We were able to show, for instance, that the retail area best known to business executives in Nassau does only a fraction of the retail business done in a community to the south which, because of accessibility, draws the mass market.

The same misconceptions exist in placing the concentration of real wealth, or buying power, in certain areas. A map of communities showing the average value of private houses completely changed the management's thinking in several areas considered.

A potent argument for better and more careful research in site location is the extraordinary mobility we find in the different metro-

politan regions in which most modern developments are occurring. *The regions are growing faster than the cities in their centers are decentralizing.*

New York is an interesting example of this. Although there is a great deal of talk about decentralization, the facts show a statistically tiny commercial movement away from the city. The obvious group seeking space away from New York is the manufacturing group needing room for horizontal development. The second important "decentralization" is an important one socially and involves the exodus of 60,000 people each year, as mentioned before, who are

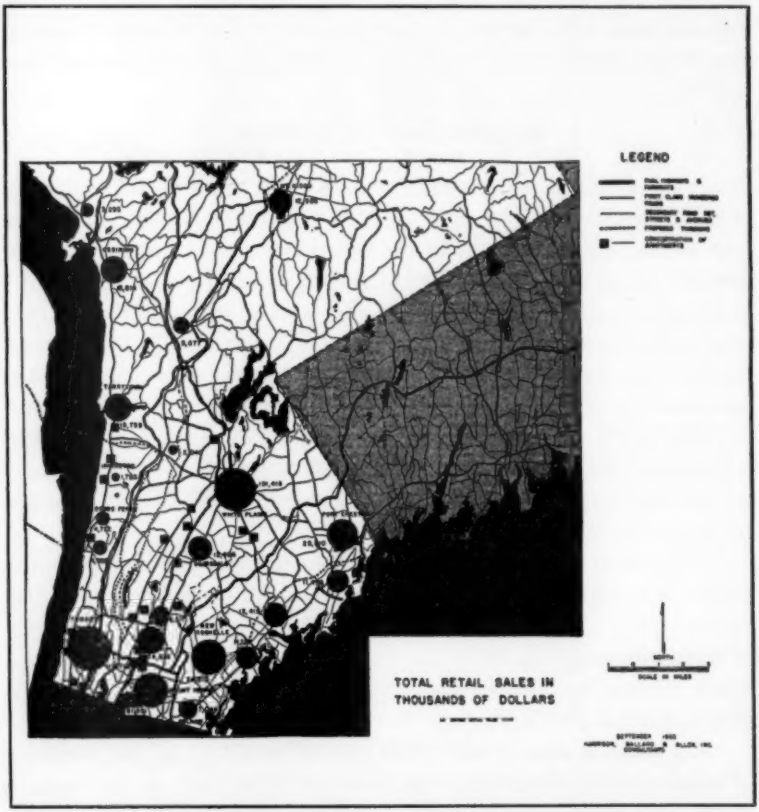


FIGURE 4. Retail sales concentrations mean daytime shoppers. The demand for restaurants is directly related to apartment concentrations.

driven away by social and racial conflicts, poor schools, and poor recreation facilities.

In New Rochelle, a suburban city adjoining New York, the greatest number of new home owners comes from the suburban area itself, the second largest group from outside the entire region, the third from New York City. The region, outside the city, absorbs the great majority of new families attracted by employment opportunities who are deterred from moving into the city for the same reasons that thousands are leaving it each year. The new vitality seen in all regions stems from these multiple reasons rather than from a simple factor of decentralization. Of course, only a few have considered what will happen if and when the public at large comes to grasp the realities and potentialities of nuclear and thermo-nuclear warfare.

### Scientific Analysis Basic to Site

It is truly astonishing how many decisions to locate important commercial investments are made against a flimsy background of maps and accessibility data. One of the real reasons is that, too often, the location is set as a result of a real estate promoter's sketchy information or of a real estate broker's efforts to make a quick deal. It is generally accepted that traffic itself should be analyzed and reported upon by a traffic specialist. But the day of scientific analysis as a basis for site selection on other counts has not fully arrived. Some of the biggest national concerns employ brokers for site selection who take traditional pride in working by hunch. Many of these men do not have access to future highway plans nor do they think in terms of long-range development.

To be sure, the shopping center business has grown to a point where very expert help in market analysis, traffic and site planning are accepted prerequisites to successful promotion and financing. This is not generally so in the field of other commercial development depending upon accessibility—restaurants, motels, hotels, offices, branch banks, professional offices, and others.

Regional studies similar to the restaurant survey reveal a variety of needs derived from the new diversity of activity in the regions themselves. Until recent years, we were mainly concerned with residential areas and suburban development. Commercial facilities

and services were related to residences. Today, the recent advent of new industries to the metropolitan regions and the great size of residential developments themselves generate demand for important investments which were heretofore only considered in relation to downtown centers.

Nassau, the fastest growing county in New York State, attracts new industry primarily because of the great, new skilled-labor supply created by relatively cheap and good housing. By 1970, there will probably be a million people living in Nassau. Department stores

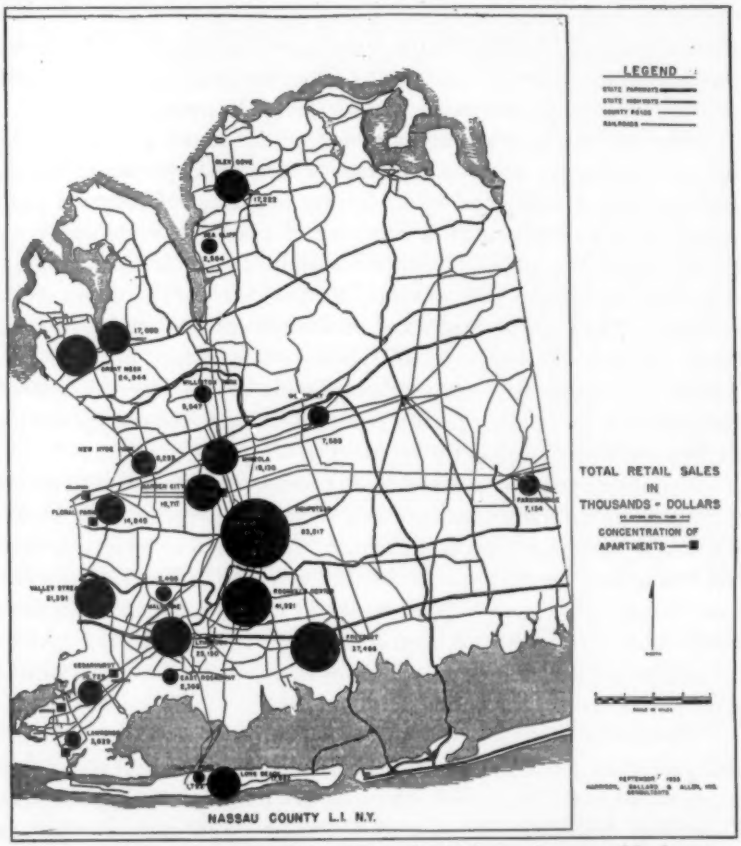


FIGURE 5. The real facts of retail trade are clearly shown (compare Manhasset—miracle mile—with Hempstead). Note the accessibility of the important centers over local roads.

are just beginning to seek this market; there is a dearth of good restaurants, and only one hotel with three hundred rooms. Entertainment facilities similar to the older downtown ones are far behind in meeting the demand; professional centers and office buildings are badly needed. These needs, being county-wide, must be planned upon the solid base of accessibility.

The average executive doesn't grasp how fast the regions around our big cities are changing. He is generally too busy to go and see for himself. A man in the Washington, D. C. area wouldn't believe his eyes if he were to see the Silver Spring community for the first time since the war. A brand-new city, now the second largest in Maryland, has simply mushroomed into being. We consider it our job, as consultants, to show the executive just what is really going on.

Also moving forward at an almost phenomenal pace are plans for new highways and roads in nearly all our large metropolitan regions. The average real estate broker has only information published in newspapers and is unaware of planning commission or public works blueprints. To forecast highway developments to the finest point possible is an obvious need on the part of commercial concerns entering into leases and commitments for twenty years or more. To a traffic engineer this appears elementary but it is important to emphasize here that even some of the largest national corporations are not getting this type of thorough, long-range advice in determining new sites for regional development.

A prominent bank in a New York suburb recently asked us about the wisdom of moving next door in its downtown location and building a new building to replace the one constructed in 1939. No consideration had been given, in this fast growing community, to the vast changes almost certain to be made in the next ten or fifteen years. And no thought had been given to the probable advantages in having branches established in regions where bank customers would have easy access by automobile.

We believe there is a great need for planning services which will evaluate areas in terms of long-range changes. We find that important commercial and investment decisions are made every day without long-range consideration, one of the most important of which is accessibility. We would hope that professional planners everywhere will accentuate the important role of the traffic engineer.

# A Survey of The Uses of Radar in Speed Control Activities

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R–A–D–A–R . . . radio detection and ranging . . . a term which became familiar during World War II in connection with diversified types of scientific instruments, is being used by an ever-increasing number of state, county, and municipal enforcement units. The accuracy of this electro-magnetic device is impressive. This factor, coupled with public willingness to accept scientific methods in an effort to minimize or eliminate the element of human error, has resulted in general acceptance of the principle.

As much as possible, the enforcement arm of the traffic safety movement seeks to use scientific methods not only in determining sound statutes and regulations, but also in enforcing these statutes and regulations.

The Electro-Matic Speed Meter (radar) is one of the more recent scientific contributions which reportedly has been accepted for use by state, county, and muncipal departments in more than forty states. This device calculates and identifies the speed at which a vehicle is moving, and has been found to be accurate to within two miles per hour.

In enforcement circles, as well as in education and other areas of activity, there usually is a reluctance to accept the novel or the untried. In many instances, this reluctance can be traced to the

difficulties encountered in interpreting effectively new enforcement practices and methods to the public. Experience has indicated enforcement policy and enforcement methods to be effective only to the extent they are understood and supported by the electorate.

The effectiveness of radar thus far is fairly well known. However, there is reason to believe that a limited amount of reluctance, skepticism, and disbelief still exists about using it as a tool in building and maintaining an effective traffic safety program. It is believed that much of the reluctance of enforcement officials to employ this medium is due to a lack of communication among the various agencies already using the device.[1]

## Purpose of the Study

The primary purpose of this study was to determine the exact status of the use of radar. What experiences have various using agencies or departments had that others might profit from? What techniques have been employed? What technicalities have arisen? How has public support been obtained and maintained? What has been the accident and violation experience in areas where the device has been used?

From the experience of agencies and departments now employing the device, others contemplating its initiation will benefit and those currently using it will be able to do so more effectively. In this manner, much of the "guesswork" will be eliminated. The report is not an attempt to evaluate either the device or its use. Rather, it is designed to present as objective a picture of current practices as possible on the basis of the sampling returns.

Participating in the study were the State Police of Connecticut, Delaware, Maryland, New Jersey, Pennsylvania and Vermont, along with the State Highway Patrols of Arizona, Mississippi, North Carolina, Ohio and Washington. These agencies reported on their experiences on a state-wide basis. Also participating were the police departments of the following cities:[2]

[1] A thorough, illustrated description of the theory, design, and operation of radar as applied to speed control activities is contained in John Barker's article: "Radar Measures Vehicle Speeds," which appeared in the July, 1949 issue of *The Traffic Quarterly*. pp. 239–250.

[2] These 36 cities are located in 15 states. In all, 21 states participated in the survey.

Akron, Ohio
Birmingham, Michigan
Buffalo, New York
Chattanooga, Tennessee
Cincinnati, Ohio
Cleveland, Ohio
Columbia, South Carolina
Cumberland, Maryland
Dayton, Ohio
Deal, New Jersey
Des Moines, Iowa
Durham, North Carolina
Fort Wayne, Indiana
Garden City, New York
Gary, Indiana
Greenburgh, New York
Greenwich, Connecticut
Indianapolis, Indiana
Manchester, Connecticut
Mansfield, Ohio
Medina, Ohio
Memphis, Tennessee
New Rochelle, New York
Oklahoma City, Oklahoma
Princeton, New Jersey
Raleigh, North Carolina
Reno, Nevada
Rochester, New York
Rocky River, Ohio
Royal Oak, Michigan
Salem, Oregon
St. Louis, Missouri
Toledo, Ohio
Waterloo, Iowa
Wooster, Ohio
Youngstown, Ohio

### Analysis of Questionnaire Returns

Seventy-eight agencies and departments were questioned on the uses they make of radar in speed control activities. Of these, forty-nine agencies or 64 percent responded to the questionnaire.

Ninety-six radar sets were reported in use by these forty-nine agencies. Of these, fifty-one sets are accompanied by a graphic recorder which makes it possible to obtain a permanent tape or chart record of the speeds attained by the vehicles observed.

Insofar as operators are concerned, twenty-five agencies, half of those participating, reported that they use special personnel to operate the radar equipment. It appears that restricting the use of the instrument to specialists is preferred by authorities in the field.

Instruction on the equipment's operation at the time of its acquisition was reported adequate by approximately 60 percent of the agencies replying. In the case of the remaining agencies, additional instruction was indicated as being received, usually by a factory-trained representative or a radio technician. A few agencies received additional instruction from neighboring enforcement agencies.

Twenty-two percent of the respondents use radar for conducting speed checks in residential areas where residents had reported ex-

cessive speeds. In these situations as well as in others, certain agencies reported that they invited citizens to observe the demonstrations. In these instances, generally it was found that traffic was not moving as fast as had been reported.

## Techniques of Use

Numerous techniques of use were reported, many designed to meet specific situations.

Both marked and unmarked vehicles were used, with marked vehicles slightly in the minority. In certain states (Ohio for example), the law requires marked vehicles when they are used exclusively for enforcement of traffic laws.

A variety of media was employed as to placement of the transmitter-receiver unit. Among the locations indicated were:

1. In the trunk of the car, with the cover or lid open.
2. In the trunk of the car, with cover or lid closed (in these instances, a secion of the trunk cover or lid was replaced with an insert of plexiglas to simulate the cover or lid when closed).
3. On the ledge inside the rear window of the car.
4. On a stand mounted on the car.
5. On a stand placed independently of the car. (The newer model of the Speed-Meter is adaptable to a special tripod for this purpose.)
6. On the top of the car.
7. On the hood of the car.
8. In the rear of a station wagon or panel truck, with the rear open.

With the exception of those reporting a permanent-type fixture or bracket, several respondents indicated using a variety of locations for the apparatus.

In response to inquiries relevant to warning signs in conjunction with radar speed detection, 86 percent of the respondents stated that permanent-type warning signs were used; 66 percent used temporary-type warning signs only when the radar sets were in actual operation, while a few reported using signs of both a temporary and a permanent nature. It is believed that warning signs tend to minimize the complaint of "speed traps" often voiced by the motorist.

The erection of signs to notify the motorist is an elective of the particular agency, except in certain instances. In Ohio, for example, the law specifies that a sign reading, SPEED METER AHEAD, must be erected at least 750 feet and not more than 1,500 feet along the road from where the vehicles will be checked.

The checking of traffic moving in one direction only was reported with more frequency (80 percent) than the checking of both approaching and departing vehicles, although the latter was used, especially on narrow, two-lane roads.

### Ways of Apprehending Violators

In apprehending violators, numerous methods were reported, each of which can be assigned to one of the following categories:

1. Perhaps the most common technique reported (75 percent) was of using two vehicles. In this situation, an officer in one vehicle equipped with radar and radio-telephone would identify the violator. Another officer, in a second vehicle, would be stationed some distance ahead (this distance was found to vary from one block to one and a half miles). The operator in the first vehicle calls the second vehicle-operator and advises him as to the identity of the vehicle driven by the violator. The second-vehicle officer then observes approaching traffic and stops the violator-vehicle.

2. A similar method involves three vehicles; one equipped with radar, and two pursuit or apprehending vehicles, one to the front and one to the rear of the radar vehicle. This system is used when vehicles are checked in both directions.

3. In another method reported, only one vehicle was used; its occupants overtaking the offender-vehicle. The reported advantage of this method is that the occupants of the pursuing vehicle actually witness the violation.

4. Another method was that of having the operator in the radar-equipped vehicle relay the identity of the offender vehicle to a patrolman equipped with a portable radio-telephone, who is stationed some distance ahead alongside the road. This officer then stops vehicles upon receiving information from the officer in the radar vehicle.

5. Still another method required only one person by using a

500-foot cable. In this set-up, the transmitter-receiver unit was placed by the roadside with the officer taking a reading some five hundred feet farther along the road, thus enabling him to flag down a vehicle that has exceeded the speed limit.

With the Model S–1 Speed Meter, it was necessary to have a close cable connection between the indicator unit and the transmitter-receiver unit. When a distance of up to five hundred feet existed between the point where the antenna was located and the point where the officer could read the speed, it was necessary to use the graphic recorder as the indicating device. In the redesigned Speed Meter (Model S–2), only a small, two conductor cable connects the indicator unit to the transmitter-receiver-power unit and hence a 500-foot distance is easily obtainable without bringing into play the graphic recorder (unless a recorder also is desired). This arrangement now makes the advantages of radar available to departments who wish to assign only one man to radar work.

### Radar and Law Enforcement

While most individuals associate law enforcement—as it pertains to speeding—with speed in excess of the posted limit, certain agencies reported using radar to identify drivers operating their vehicles at a speed so slow that they interrupted the normal flow of traffic.

As a facet of traffic engineering operations, radar was reported used by certain agencies to determine speed limits for specific areas. In these instances, graphic recordings were maintained over a specific period of time to determine the speed at which the average motorist was traveling. These data then furnished a partial basis for initiation of speed limits or revision of existing ones.

Where it was desired to determine frequency counts or traffic density, the graphic recorder was reported as being used with considerable frequency. In such cases, the radar equipment was set up as a portable unit with a six-volt car battery.

One agency reported a study to determine the effectiveness of speed control signs. By checking on speeds at which vehicles passed through posted zones for varying periods of time and by checking speeds at various distances from the speed control signs, it was possible not only to arrive at more objective speed limits, but also to

place signs at what was believed to be the most appropriate locations. Included among the findings of this particular study was the observation that as the speed limit decreased, the number of violations increased. These findings are comparable to those of other studies conducted by the Center for Safety Education.

Commenting on Connecticut's experience, John C. Kelly, Commissioner of the State Police, reports: "At present it (radar) is spearheading our efforts in speed control on highways and bridges where such violations or accident-experience warrant."

### Advance Publicity for Radar Speed Control

Perhaps with the philosophy in mind that the more effective the interpretation of a novel device, the greater its possibility of being accepted, a majority of agencies reported extensive publicity campaigns preparatory to radar speed control activities. This preparation lasted from two weeks to approximately one year, with the majority of respondents indicating an advance preparation of approximately one month. Only one agency, of forty-nine reporting, indicated that advance publicity was not used.

Among the advance publicity media employed were the newspaper, radio and television, along with demonstrations to the public, various organizations, and court officials. In addition, many agencies reported the use of verbal or written warnings to speed violators prior to making actual arrests for violations once the device was placed into operation.

A rank-order of the media employed showed the press to be the most used of the communicative media (90 percent), with radio and television following in that order. In a limited number of instances, demonstrations to the public, the press, and to court officials helped to familiarize them with the device and its operation.

A report, perhaps representative of the effectiveness of the educational effort extended prior to initiating radar speed control, is that of Arthur H. Mehring, Lieutenant of the Cincinnati Police Department, who states: "Our 97 percent conviction record we believe can be partially attributed to the educational program which preceded the enforcement."

Twenty-four percent of the departments reporting issued verbal

warnings to violators for a limited period of time after the radar apparatus had been installed. Special warning tickets were issued by other departments, apparently with successful results. The Cincinnati Police Department issued *ten thousand* written warnings within a six-month period. Each warning was accompanied with an invitation for the person to inspect the equipment in operation.

Communities planning to introduce radar speed control activities are encouraged to conduct an educational campaign prior to, and for a limited time after, beginning the campaign.

The reported reaction of the public, the press, and judicial groups was that they liked best the actual on-the-street demonstrations presented by competent persons. Such demonstrations, it was felt, not only familiarized the general public with this new educational and enforcement tool, but also permitted judicial officers to observe firsthand a device, the accuracy and operation of which would play a major role in the acquitting or convicting of an apprehended motorist.

Certain of these public demonstrations employed, in addition to the more conventional communicative media, mobile public-address systems, both to caution the public that a demonstration was underway and to encourage attendance at the demonstration.

## Warnings and Arrests

Foremost among the responsibilities of the law enforcement arm is that of crime prevention. A considerable amount of prevention can be derived from warnings and from arrests, if these become necessary. Arrests, in general, serve two functions: to prevent or deter the offender from repeating his violation, and to act as a deterrent to others.

While many in the area of enforcement like to believe that a warning can be effective in reducing speed, evidence seems to indicate that often these warnings do not have the effect desired. Largely as a result of the ineffectiveness of warnings, arrests are initiated.

Well over half of the agencies queried in the study reported using a combination of arrest and warning in their speed control activities. Two of the departments reported only warnings in their radar speed enforcement program, although reportedly warnings

were used extensively by other agencies in public information programs preparatory to the initiation of radar speed control in the area.

Experience has indicated that arrests can be effective in reducing speeds in specified areas. The speed limit should be determined by other than empirical reasoning and should be enforceable as well. Reports from many areas point to the advisability of rotating mobile speed control enforcement units so as to sample all sections of the area served by a particular agency. Such rotation has proved effective in combating the violation problem resulting from the action of the motorist who complies with the posted limit only when he believes the limit is enforced.

It is the opinion of many enforcement personnel that arrests result frequently in uncooperative attitudes on the part of those apprehended. The use of arrests and warnings, then, appears to be a problem that each department should solve largely on the basis of its accepted philosophy of crime prevention.

In answer to the inquiry relevant to speed-violation experience subsequent to the employment of radar, the respondents generally agreed that violations for speeding had decreased, although a limited number of agencies reported no noticeable change, while still others had insufficient data upon which to base a conclusion.

Ralph S. La Civita, traffic engineer of the Youngstown, Ohio police department, reports:

> .... since the advent of radar our traffic deaths have dropped from twenty-four to six last year. Youngstown placed *second* in cities of 100,000 to 200,000 (according to the National Safety Council's ratings).

### Attitudes of the Public and the Press

On the whole, reaction of the public to radar speed control was reported favorable, although a few unfavorable reports were indicated. Generally, this opposition could be traced to fear of "speed traps." As the public became educated to the proper use of radar, these fears were found to disappear. Commissioner Kelly of Connecticut reports: ".... Public acceptance of our methods of traffic control has reduced accidents and speeding violations and has aided in speedily clearing up complaint areas."

Press acceptance was reported to be exceptionally good, with only one instance cited in which a paper opposed its use. Later, however, this paper accepted the use of radar in speed control activities.

Mississippi reported that approximately fifty feature stories on radar appeared in newspapers throughout the state and in the adjoining states of Tennessee and Louisiana.

It was generally agreed that a requisite to the success of the program was the support given to it by the press.

## Attitudes of the Court

The acceptance of radar by the courts, according to reports received, was practically unanimous. An educational program prior to the installation of radar, it is believed, did much to achieve this judicial sanction.

While the legality of apprehending an individual motorist for exceeding a posted speed in a particular area by means of radar has been questioned by certain motorists and court officials, so far as is now known, there have been no decisions concerning the use of radar by a court of appellate jurisdiction.[8]

Reports indicate that most complaints on the part of motorists are directed not toward the accuracy of the device, but rather toward the possibility that the observer or the arresting officer may have singled out the wrong vehicle.

Relevant to the the accuracy of radar, Colonel George Mingle, superintendent of the Ohio State Highway Patrol, reports: "Accuracy has not been contested. No cases were reported to have been appealed to a higher court. A few cases have been acquitted because of other legal technical aspects not involving the radar." In another supporting statement, Ralph W. Moxley, chief of the Birmingham, Michigan police department, states: "In approximately 4,000 arrests only four cases were contested. All were found guilty. None of the motorists contested engineering accuracy."

These and similar reports have implications for the selection and preparation of personnel to operate the equipment as the success of the program depends, to a considerable degree, upon the competence of the operator and upon his integrity.

[8] Judge Geraldine F. Macelwane, "A Judge's Eye View of Radar." *Traffic Digest and Review*. I (December, 1953), p. 5.

The National Safety Council, which has endorsed the application of radar speed control activities, reports no general attempt of courts to block evidence obtained by radar.

### Other Uses of Radar Reported

It was interesting to note the variety of uses indicated by certain respondents. Most of the uses, other than those of identifying the speeds of vehicles, were associated with traffic engineering functions. In this facet of the traffic safety program, radar was reported as being used extensively in conducting both speed and volume checks. Such data are invaluable in planning immediate and long-range highway improvement. By the graphic recorder, one can obtain not only a record of the number of vehicles passing through a given area in a specified period of time, but also a record of the speeds at which these vehicles are traveling at the time. These data are of particular value to the traffic engineer in his many activities.

A limited number of respondents indicated that their radar equipment periodically was used to check the speeds of such passenger conveyances as railway vehicles and trains, and also freight trains. These are examples of surface transport which do not lend themselves to conventional methods of speed checking.

It is acknowledged that the speedometer of an enforcement vehicle must not only be operative, but accurate as well. Often the arresting officer is called upon to testify as to the accuracy of his vehicle's speedometer when he has apprehended a violator for speeding, through pacing the violator in a vehicle. The Speed-Meter affords a valid criterion against which to compare the accuracy of vehicle speedometers, and it is quite possible that radar will be used in the future to check the accuracy of speedometers in private vehicles, during periodic motor vehicle inspections and at other times as directed by enforcement authorities.

A few fleet owners are reported to be using radar equipment for checking on the speeds at which their drivers travel. Others have reported using radar for checking the accuracy of the tachographs of their vehicles. These uses also contribute to the over-all success of speed control activities on the part of enforcement agencies.

While it is not considered practicable to review the experience

of all departments reporting, the following are examples of the findings of certain departments included in the study.

### New Jersey's Experience

Radar has been found an effective means of detecting speed violators on the New Jersey Turnpike. Of the average 250 summonses issued weekly for speeding, over half of the violators are detected by radar.[4]

A report, appearing in the Teaneck *Sunday Sun*, March 7, 1954 stated:

> . . . Radar is effectively curbing speeders on the New Jersey Turnpike and helping to improve the highway's fine safety record.
>
> During 1953, the first year of radar's use, the accident and fatality rate showed sharp reduction. The fatality rate dropped 32 percent, to levels far below those of parallel highways in New Jersey, and the nation's highways as a whole. Radar was responsible for the apprehension of twice as many reckless drivers in 1953 as were apprehended by the entire detachment of State Police assigned to the Turnpike in the previous year.

New Jersey's favorable experience with radar has not been limited to the Turnpike. John J. Rehm, Jr., Chief of Police of Deal, New Jersey reports:

> "Our accident rate has been the lowest in the history of the borough since we have installed this (radar) speed control system."

### Mississippi Highway Patrol's Experience

The Analysis Report of the National Safety Council, based upon the returns of the *Annual Inventory of Traffic Safety Activities*, noted that in 1952, Mississippi made the most extensive use of electronic devices for speed control of any state in the nation.[5]

In response to the questionnaire, it was learned that over six thousand arrests of speed violators have been made through the use of radar. Of these, only three cases were appealed.

The late Captain A. S. Windham, administrative assistant, Department of Public Safety of the State, attributed Mississippi's re-

[4] Colonel Russell A. Snook, "Policing the New Jersey Turnpike," Traffic Digest and Review. I (August, 1953), p. 12.

[5] John Carruth, "Patrol by Radar," Public Safety. XLIV (September, 1953). p. 39.

duction in fatalities to radar: "In every district where we have used it, fatal accidents were reduced."[6]

### Center for Safety Education Study

Through a special grant from a friend of the Center, and through the use of a car donated by the Ford Motor Company, the Center was able to equip and operate a mobile research laboratory on the streets and highways of fourteen of the Eastern states in the summer of 1953. To aid in determining accurately the speed of traffic, the car contains an Electro-Matic Speed-Meter which operates on the principle of radar. Prior to this tour, the Center had conducted pilot studies of the practices of drivers, especially as regards speed, in the northern New Jersey area.

The Center was invited to work in close cooperation with state and local officials on hundreds of speed checks and demonstrations. The tour covered approximately 12,000 miles and produced direct contact with some 3,000 officials and citizens (not to mention those reached indirectly by newspaper, radio, and television). Three main objectives were formulated: (1) to achieve a better understanding on the part of officials and citizens about the use of the more modern pieces of police equipment, (2) to educate police officials in the proper use of radar equipment and to assist them in the techniques of educating violators of speed limits, and (3) to collect data on highway traffic with specific reference to speeding.

General conclusions drawn from the data obtained during this four months' study are as follows:

1. The speed violators had no special composition: all age groups and practically all professions were represented. No real differences in regard to the sex of violators were noted.

2. All makes of cars and models were proportionately represented.

3. Congestion during so-called "rush hours" seemed to keep the average speed below the posted limit. As a result, drivers tended to evidence discourtesy, to blow their horns more than necessary, and to take more chances than perhaps they ordinarily would take.

4. Interestingly, National Safety Council figures show that the

[6] Ibid, p. 39.

night-traffic death rate is three times that of the daytime rate, although data obtained from the study indicated no differences in speed rates from day to night.

5. Speed violations were most numerous in low-speed limit zones. In a few cases, violations ran to 99 percent. As the speed limit increased, the number of violations decreased.

6. It is also interesting to note that during the period of this Eastern tour, when police officials were concentrating on speed control, there was a marked reduction in fatalities; the rest of the nation suffered an increase.

During the course of the academic year 1953–54, a limited number of surveys and demonstrations were conducted, and during the summer of 1954, the Center continued the work begun the previous summer in conjunction with the SLOW DOWN AND LIVE campaign sponsored by the Governors' Committee of twenty-four states in the East.

In addition, the Center has studied driving habits of the motoring public by using radar equipment in various areas under varying conditions.

Still another of the Center's activities along these lines is to make the device familiar to the many driver-education instructors enrolled at the University each year.

These, then, comprise the Center's major efforts at introducing this traffic safety tool into the traffic safety programs of many of our states.

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# Toll Roads Will Solve Indiana's Transportation Problems

ALBERT J. WEDEKING

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FOR YEARS the people of Indiana were faced with the question —"How long can we afford to wait for the roads that we need now?" As one construction season succeeded another, and as maintenance costs mounted from year to year, those interested in highway transportation became acutely aware that highway facilities were lagging far behind their attempt to meet the requirements of modern transportation. They had three alternatives:

1. Increase taxes to such an extent that the State Highway Department could build the super-highways needed now.

2. Permit the condition to go from bad to worse and see the state's investment in freeways become more and more inadequate to serve the needs of the people who use them.

3. Enlist the aid of private capital for the building of roads and let those who use the roads pay for their use; and over a period of years repay the investors who furnish the funds to build them.

The first alternative was not feasible for obviously a General Assembly is always reluctant to impose a tax rate sufficiently high to enable the highway department to do the things obviously necessary. With the present revenue of the highway department, many years would be required to provide facilities that all interested persons recognize as not only desirable but actually needed now.

The second alternative would contribute nothing toward solving

the problem, but would permit the state highway system to become increasingly hazardous to motorists and increasingly expensive for the highway department to maintain. The state administration is definitely committed to removing insofar as possible every highway hazard, and through a survey has learned that a complete job in this respect would require many millions of dollars, far in excess of the money now available for that purpose.

### Toll Road Commission Set Up

In view of these situations toll roads became the only answer, and in 1951 the Indiana General Assembly passed the Toll Road Law. This law provided for the appointment by the governor of a commission consisting of four members—no more than two of whom shall be members of the same political party. The chairman of the state highway department is a member ex-officio of the Toll Road Commission, without compensation.

Following the appointment of the first commission, steps were immediately taken to test the constitutionality of the Toll Road Law. The Indiana Supreme Court upheld the constitutionality of the Act in an opinion rendered on November 17, 1952.

Subsequently, the commission initiated plans for the construction of Indiana's first modern toll road—a 156.1-mile east-west road across the northern part of the state, connecting the western terminus of the Ohio Turnpike with the Calumet area of Hammond, East Chicago and Gary.

A second toll road of 141 miles between Hammond and Indianapolis, the state capital, is now in the preliminary stage.

Cost of the first road will be $280,000,000 and a preliminary estimate on the Hammond-Indianapolis road is $225,000,00. This includes financing charges in both cases.

Need for an Indiana east-west toll road to absorb the traffic output from Ohio's Turnpike was quickly recognized by the first toll road commission. In accordance with statute, the State Board of Finance—the State Budget Committee—then approved the transfer from state highway funds of a sum totaling $358,000. These funds were to cover the cost of the engineering study required to determine the feasibility of an east-west road. Under the terms of the

statute the money thus advanced from state highway department funds was to be reimbursed to the department when and if bonds were sold to provide funds for constructing the east-west road.

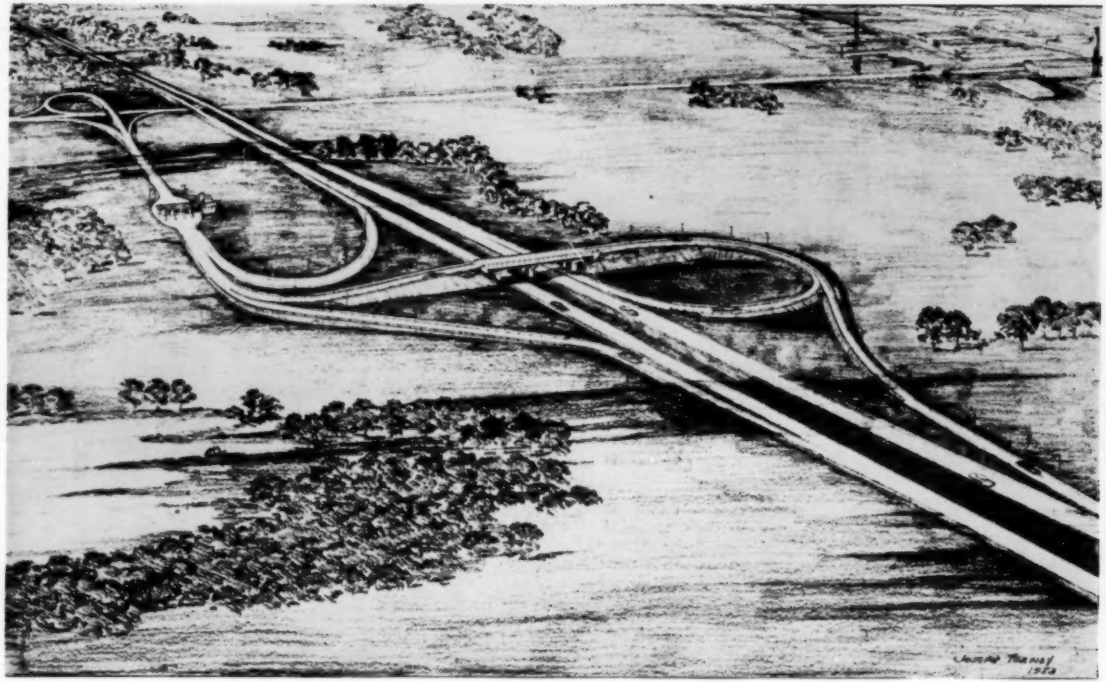
When these funds became available the toll road commission engaged the services of two engineering firms—one to report on traffic and earnings, and the other to report on the cost of the east-west road. From their reports it was determined that the road was feasible, and steps were then taken to sell revenue bonds to provide for its construction. The $280,000,000 worth of bonds were sold in December, 1953, at a net interest cost of 3.56 percent. Immediately thereafter the cost-finding firm was engaged as general consultants, and working with the commission it proceeded to negotiate contracts with a number of consulting firms to prepare plans for the new east-west road. These plans are now rapidly being completed, and the toll road commission expects to place under contract a large portion of the work before the end of the year.

### Modern Design for East-West Road

The road will be designed according to the most modern engineering principles. The roadway pavement will be reinforced Portland cement concrete twenty-four feet wide—ten inches thick—on a six-inch granular sub-base material. Each laying will be flanked by a ten-foot shoulder on the outside and an eight-foot shoulder on the inside, surfaced with bituminous macadam to provide safe berms for motorists who find it necessary to leave the pavement surface.

Between the two 24-foot pavements will be a median strip 56 feet wide which will include the 8-foot berm on the inside of the pavement surface. The 40-feet-wide unpaved portion of the median strip will be seeded to grass. The standard right-of-way width is set at 300 feet, but in the highly industrialized areas of the Calumet Region, this right-of-way width will be reduced and much of the road will be elevated so as not to interfere with north and south traffic.

To bring about the maximum in safety factors, the minimum sight distance will be 900 feet to an object in the road four inches high. The minimum headlight sight distance of 1,000 feet will be provided at depressed portions of the road and at vertical curves.



View of typical interchange.

Ascending grades will be limited to 2 percent—descending grades may be as high as 4 percent. Horizontal curves will be limited to 2½ degrees and there will be no "S" curves or compound curves.

To provide additional safety the entire right-of-way will be fenced, and the only authorized access to the toll road will be at the eleven interchanges—one at the Indiana-Illinois line, another at the Indiana-Ohio line, and nine intermediate interchanges. Four of the nine interchanges will connect with U. S. highways and five will connect with important state routes. Five spacious service areas will be provided on each traffic lane where motorists may obtain food, non-alcoholic beverages, and the usual gasoline service-station facilities. These service areas will be opposite each other on the toll road and will provide the highest standard of service-station and restaurant facilities.

Adequate and modern communication facilities will be used to make travel on the toll road pleasant and safe. Policing of the toll road will be done by a special force of state police, under the direction of the Indiana State Police Department. All laws governing traffic on free highways will be applied to traffic on the toll road. A schedule of toll charges has been set up by the commission as follows:

| | One Way Through Trip | Toll Per Mile |
|---|---|---|
| Motorcycles | $ 0.95 | $.00608 |
| Passenger Cars | 1.95 | .01249 |
| Passenger Car with trailer | 2.40 | .01537 |
| Light Trucks | 1.95 | .01249 |
| **Gross Weight** | | |
| Truck and/or combination units up to 16,000 pounds | 3.05 | .01953 |
| Truck and/or combination units up to 20,000 pounds | 4.35 | .02786 |
| Truck and/or combination units up to 24,000 pounds | 4.65 | .02978 |
| Truck and/or combination units up to 30,000 pounds | 5.20 | .03331 |
| Truck and/or combination units up to 35,000 pounds | 6.05 | .03875 |
| Truck and/or combination units up to 45,000 pounds | 7.75 | .04964 |
| Truck with full trailer up to 65,000 pounds | 10.35 | .06630 |
| Truck with full trailer up to 85,000 pounds | 13.60 | .08712 |
| Buses—up to and including 12 passengers | 3.05 | .01953 |
| Buses—12 passengers and over | 6.05 | .03875 |

(Toll charges will be proportionate to length of trip)

The traffic and earnings survey estimates that the east-west road will produce an average annual gross revenue from tolls and con-

cessions of $26.5 millions over a 37-year period beginning with its first full year of operation. The completion date for the entire east-west toll road has been set for November, 1956. The location of this road was selected largely because it would remove from existing free highways the tremendous traffic load coming across Indiana, both from the east and west. Since the gasoline tax collected from motorists who use the toll road will be distributed through the Motor Vehicles Fund to state, counties, cities, and towns for use on free roads, the diversion of this traffic will in no way affect the revenues now accruing to the state Motor Vehicles Fund. The use of the toll road, however, for carrying the heavy volume of transcontinental traffic will reduce the maintenance costs on parallel roads to an appreciable extent and thus the toll road will in no way hinder the development of the system of free highways, but will rather promote development in two ways—by providing revenue, and by reducing the traffic load.

### First Hoosier Toll Road in 1840

Inauguration of this modern toll road program has caused a revival of interest in Indiana's historic position as a pioneer of toll-road building in the Midwest.

Indiana had a toll road as early as 1840. It was a 41-mile rocked road built through the wilderness and rugged terrain of southern Indiana. It linked the towns of Paoli in Orange County and New Albany on the Ohio River. This initial Hoosier toll road gave southern Indiana farmers and merchants their first transportation outlet to the Ohio River and produced as a result a small-scale industrial and agricultural revolution in that section.

The old Paoli-New Albany Turnpike, as the road was known then, was state-operated for eleven years and then sold to private interests which operated it successfully for another forty-eight years. The road was part of a $13,000,000 internal-improvement program provided by the state legislature of 1836. This ambitious program charted construction of a series of canals, railroads and toll roads, but the Paoli-New Albany road was about the only one of these facilities finished and operated successfully.

Although the state's toll road law was enacted by a previous administration, the present governor has been a leading exponent of

toll roads as a partial solution to the huge postwar increase in traffic accidents. The governor recognizes that under existing revenues, the state is unable to finance immediate elimination of many traffic hazards such as narrow bridges and sharp-breaking curves in the free road system. He therefore has advocated toll roads to provide safe travel in the most congested areas, but only where the traffic demands them. This generally would be in high accident areas.

The east-west road, for instance, will parallel the infamous "death-a-mile" U.S. Route 20. Statistics show that Route 20 is Indiana's leading killer highway, especially at the outskirts of the Calumet area. Thus, the east-west toll road is expected to absorb some of the heavy traffic on Route 20 and reduce the accident death toll as well as property damage.

The best feature of toll roads so far as Indiana is concerned is that they are privately financed and do not cost the taxpayers a single cent. The governor has stressed this repeatedly.

It has been estimated that $725,462,000 would be required to bring Indiana's road system up to standards prescribed by the American Association of State Highway Officials. Assuming that the present state highway department revenue remains the same as it was during the 1953–54 fiscal year, it would take more than twenty years to bring Indiana's road system up to this standard.

To do the job in ten years, double the present revenues would be required. It is doubtful if any legislature could be expected to double the present income of the state highway department even if the state could afford it. Experience shows that people can have *now* the roads they need *now* if they will build them with funds provided by private investors. Thus, toll roads offer the solution to Indiana's transportation problem.

In solving the transportation problem, they alleviate hazardous conditions on our free highways and lives will be saved as a result.

# Surveys in Miami Show Stability of Origin-Destination Patterns

MELVIN A. CONNER AND SHERWOOD H. HILLER

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*Mr. Hiller has for three years been assistant engineer of traffic in the division of traffic and planning of the Florida State Road Department, in charge of urban surveys of Miami, Sarasota, Orlando and other special studies. Previously Mr. Hiller was on the staff of the planning survey division of the New Mexico State Highway Department, as field supervisor of the Albuquerque parking survey and office engineer on capacity studies of that survey. He is an associate member of the Highway Research Board, and a member of the subcommittee on traffic engineering of the Florida State Traffic Coordinating Committee.*

DURING the summer of 1950 and the winter of 1950–51 two separate origin-destination surveys were conducted in the Miami, Florida, metropolitan area. These studies, supervised by the State Road Department of Florida through its Division of Traffic and Planning, used the home interview method developed by the United States Bureau of Public Roads. This article explains the need for two studies within such a short period of time, presents some of the comparable data obtained by the studies and suggests areas for research which might prove fruitful in simplifying future study techniques, and in keeping O-D data current once it has been obtained.

As soon as the early planning began for a comprehensive transportation survey of the Miami metropolitan area, some interesting as well as critically important problems presented themselves. Some of the problems involved only technical aspects of conducting an O-D survey in the Miami area. Of serious concern, however, was the strong, though unsupported, conviction that there were significant changes in trip patterns between the summer and the winter months.

## Area is Unique

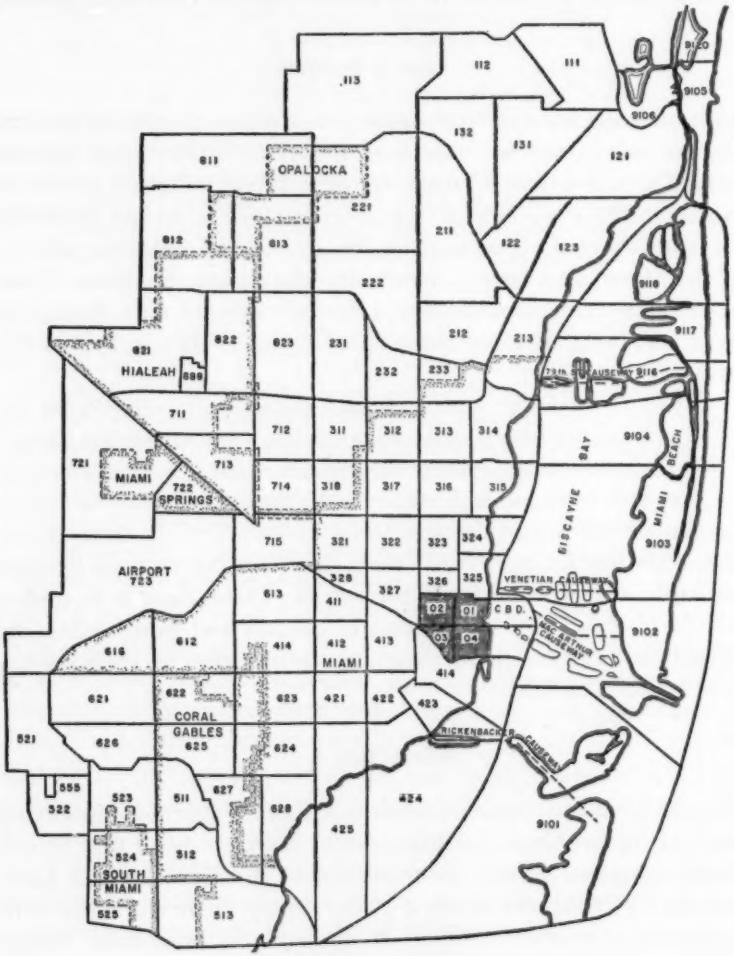
In most large metropolitan areas the question of seasonal pattern fluctuations would not have been a major consideration, but the Miami area is unique in many respects. Miami's climate and its facilities for vacationing and recreation combine to attract extremely large numbers of winter visitors. It is estimated that the population of the Miami area approximately doubles during the winter. Some of the large generators of traffic, moreover, operate only during the winter. Among these are three horse-racing tracks and the Jai Lai Fronton.

In some ways, the area presented peculiar problems from the standpoint of actually conducting an origin and destination survey. First of all, the metropolitan area consists of the City of Miami and twenty-four contiguous incorporated communities, all of which necessarily fell within the area to be studied. Second, there are accommodations for more than 60,000 transient visitors, more than are available in any other city in the nation. Third, there is an understandable reluctance on the part of officials and business men to bother visitors by stopping their autos or intruding on their privacy with home interviews.

## Miami Beach

Geographical and physical characteristics of the area aided in solving some of the problems. Examination of the map shows that Miami Beach is separated from the mainland by Biscayne Bay and Intercoastal Waterway. At the time of the survey, there were only four causeways connecting Miami Beach with the mainland. Miami Beach itself is long and very narrow. Its movement problems are of

a north-south nature and to and from the mainland. The extremely high density development with the consequent high land values severely restricts any approaches to improving the north-south facilities. In addition, the problem of attempting to conduct an internal home interview survey in Miami Beach seemed almost insurmountable since Miami Beach has about 40,000 transient accommodations.




Miami urban area zone map.

Included in this number of units are hotels, motels, apartment houses, and a few rooming houses.

In view of this situation, it was decided to handle Miami Beach as a series of small external zones as shown on the map. External interviewing stations were operated on each of the four causeways connecting Miami Beach with the mainland. Biscayne Key and Virginia Key, two islands connected to the mainland by a causeway in the southeast section, were likewise cut off by an external station.

### External and Internal Survey

The other external stations were then selected, using traffic counts. On the basis of the machine counts some of the stations were scheduled to be operated on a 24-hour basis and some for a 16-hour period. Out of a total of twenty-three external or roadside interviewing stations, six were operated 24 hours and seventeen were operated 16 hours. The volume of traffic passing through some of the 24-hour stations was so heavy that the final tabulation at six stations represents a composite day not only by eight-hour periods but also by direction as well. For example, station number 28 on the MacArthur Causeway represents six actual days of interviewing. MacArthur Causeway carried approximately 28,000 vehicles per day at that time, of which 76 percent were interviewed.

The internal phase of the survey was a normal Bureau of Public Roads home interview, using a 10 percent pre-selected sample. An attempt was made to prelist the samples using Sanborn maps but because of the almost explosive nature of the dwelling-unit construction in the area this effort had to be abandoned and recourse made to field prelisting. A total of 14,507 dwelling unit samples was selected for home interviewing.

### Rapid Multifactored Growth

It appeared necessary, before preliminary planning could proceed, to come to grips with the question of seasonal pattern changes. The problem was somewhat obscured, and made more difficult to analyze, because of the extremely dynamic growth of the area. Actually three different growth cycles had to be considered singly and in their in-

terrelationships. First of all, the permanent population base was growing at an extremely rapid rate. The population of Dade County was 267,739 in the 1940 federal census, while in 1950 it had risen to 495,084. This was an increase of 85 percent in ten years. The number of winter visitors showed an accelerated gain and in addition, the summer-vacation population was increasing steadily.

Using traffic volumes as an index, the growth of traffic and the difference between summer and winter volumes become apparent from counts made on U.S. 1 at the north boundary of Dade County.

| | *Summer* | *Winter* |
|---|---|---|
| 1942 | 2,437 | 6,027 |
| 1951 | 7,505 | 17,195 |

The problem, then, delineated certain major considerations insofar as population was a factor in traffic pattern changes:

1. A rapidly growing permanent population base.
2. A growing winter transient population.
3. A growing summer transient population.
4. Large traffic generators that were in operation only during the winter.

From a planning standpoint it was imperative to know whether trip patterns change significantly from summer to winter. Of course the only way to be sure was to conduct the survey twice, once in the summer and again in the winter. In an area of this size, conducting the survey twice meant increasing the cost an additional $75,000 to $100,000. If it turned out that there were significant pattern changes, the cost of conducting the survey twice would be more than justified.

## Survey Conducted in Two Cycles

Certain factors seemed to indicate that the changes from summer to winter would, in the main, be of a volume nature while others pointed in the opposite direction. Conferences, discussions, and study of the problem provided no reliable answer. Since no definitive conclusion could be reached, it was finally decided to conduct the survey in two cycles.

In order to make the data from the summer and winter cycles comparable, the identical internal dwelling unit samples and external stations were interviewed during both cycles. Since the three

horse-racing tracks did not operate simultaneously, nor for the entire period of the winter survey, it was necessary to obtain information concerning trips to the tracks by other methods. Each racetrack operated for only about forty days and on a staggered schedule throughout the winter months. No adequate sample of trips from all zones to each of the tracks could be obtained by the home interview method, therefore other procedures had to be devised.

This was done by interviewing on the parking lots of the tracks while they were in operation. The duplicate trip information was then removed from interviews inadvertently obtained by the home interview. Interviewing people as they arrived on the racetrack parking lots proved to be one of the most delicate public relations problems of the whole survey. This can only be appreciated by one who either has, or has observed, the "daily double fever." In subsequent tables and discussions the trips to the racetracks have been removed as they would complicate the discussion without adding materially to it.

Since the weight of expert opinion was that significant pattern changes occurred, no one was quite prepared for the picture given by the completed tabulations. Aside from the expected quantitative differences, there seemed to be little significant pattern changes.

### Comparison of Summer and Winter O-D Data

The summer cycle had a total of 579,330 trips for the average 24-hour weekday while the winter cycle produced a total of 851,890 trips for the same composite day. This is an increase of 47.1 percent of winter over summer. On page 456 is a zone map of the survey area showing some sectors for which interesting summer-winter comparisons could readily be made. They were Miami Beach, Coral Gables, Hialeah, Miami Springs, Opalocka, and the central business district of Miami.

External interviewing stations had been operated on the four routes across Biscayne Bay so that all traffic passed through one of the stations. It can be considered therefore that complete coverage was obtained on the movements to and from Miami Beach.

During the summer cycle, 61,386 trips developed between the mainland and Miami Beach. This number constituted 10.6 percent of the total trips recorded during the summer cycle. During the

winter cycle, 80,400 trips between the mainland and Miami Beach represented 9.4 percent of the total trips recorded during the winter cycle. Table 1 shows the trips between Miami Beach and four selected areas. In each case the percentages are those of the total Miami Beach trips. The differences from summer to winter are sizeable in volume but the percentages varied less than would be expected in terms of composite origin and destination average days.

Table I

Trips to and from Miami Beach as a Percent of Total Miami Beach Trips

| Representative Neighborhoods | Summer Trips | Winter Trips | Percent of Miami Beach Trips Summer | Percent of Miami Beach Trips Winter |
|---|---|---|---|---|
| Central Business District | 13,589 | 19,790 | 22.1 | 18.1 |
| Coral Gables | 4,200 | 7,009 | 6.8 | 6.4 |
| Airport | 1,124 | 2,549 | 1.8 | 2.3 |
| Hialeah | 1,280 | 1,409 | 2.1 | 1.3 |

Concluding that there was no major change in O-D trip patterns between large areas of the urban compact for the winter and summer cycles, we decided to study the data on a zone basis. Table 3 shows, for the summer and winter surveys, the number of origins and destinations for each zone for a twenty-four hour period. To give the data a common denominator and to facilitate comparisons, all volumes were expressed as a percentage of the total volume in each category.

In this form, it can readily be seen, for example, that Zone 015 generated 0.276 percent of the total summer origins and 0.281 percent of the total winter origins. It also drew 0.294 percent of the summer destinations as compared to 0.279 percent of the winter destinations. A study of the table indicates that with few exceptions each zone exerted about the same influence on the trip pattern, both summer and winter. It further indicates that the summer and winter transient population must distribute itself throughout the city in about the same geographical pattern.

Table 2 presents trip data for some additional large movements. Once again the data show volume changes but surprising percentage agreement.

## Table II

### Comparison of Summer and Winter Trips for Neighborhoods

| | Percent of Total Miami Beach Trips | Percent of Total Coral Gables Trips | Percent of Total Hialeah Trips | Percent of Total South Miami Trips | Percent of Total Miami CBD Trips | Percent of Total Miami CBD Core Area Trips | Percent of Total Miami Springs Trips | Percent of Total Airport Trips |
|---|---|---|---|---|---|---|---|---|
| *Miami Beach* | | | | | | | | |
| Summer Trips | | 4,200 | 1,280 | 190 | 13,589 | 7,020 | 290 | 1,124 |
| Winter Trips | | 7,009 | 1,409 | 253 | 19,790 | 8,844 | 478 | 2,549 |
| Percent Summer | | 5.0 | 4.0 | 1.9 | 12.8 | 15.2 | 2.5 | 5.1 |
| Percent Winter | | 6.9 | 3.5 | 2.1 | 15.3 | 15.3 | 3.4 | 8.8 |
| *Coral Gables* | | | | | | | | |
| Summer Trips | 4,200 | | 1,338 | 2,982 | 9,769 | 5,724 | 712 | 2,736 |
| Winter Trips | 7,009 | | 2,802 | 3,769 | 12,447 | 7,035 | 1,064 | 3,234 |
| Percent Summer | 6.8 | | 4.1 | 28.2 | 9.2 | 22.4 | 6.1 | 12.3 |
| Percent Winter | 6.4 | | 7.0 | 31.3 | 9.6 | 22.1 | 7.6 | 11.1 |
| *Hialeah* | | | | | | | | |
| Summer Trips | 1,280 | 1,338 | | *A/* | 2,091 | 923 | 2,768 | 2,726 |
| Winter Trips | 1,409 | 2,802 | | | 3,022 | 1,207 | 3,242 | 3,029 |
| Percent Summer | 2.1 | 1.3 | | | 2.0 | 2.0 | 23.7 | 12.2 |
| Percent Winter | 1.3 | 2.4 | | | 2.3 | 2.1 | 23.1 | 10.4 |
| *South Miami* | | | | | | | | |
| Summer Trips | 190 | 2,982 | *A/* | | 669 | 284 | *A/* | 242 |
| Winter Trips | 253 | 3,769 | | | 730 | 316 | | 228 |
| Percent Summer | 0.3 | 2.8 | | | 0.6 | 0.6 | | 1.1 |
| Percent Winter | 0.2 | 3.2 | | | 0.6 | 0.5 | | 0.8 |
| *Miami CBD* | | | | | | | | |
| Summer Trips | 13,589 | 9,769 | 2,091 | 669 | | | 792 | 1,031 |
| Winter Trips | 19,790 | 12,447 | 3,022 | 730 | | | 946 | 1,781 |
| Percent Summer | 22.1 | 9.3 | 6.5 | 6.5 | | | 6.8 | 4.6 |
| Percent Winter | 18.1 | 10.6 | 7.6 | 6.1 | | | 6.7 | 6.1 |
| *Miami CBD Core Area* | | | | | | | | |
| Summer Trips | 7,020 | 5,724 | 923 | 284 | | | 408 | 412 |
| Winter Trips | 8,844 | 7,035 | 1,207 | 316 | | | 462 | 911 |
| Percent Summer | 11.4 | 5.5 | 2.9 | 2.8 | | | 3.5 | 1.9 |
| Percent Winter | 8.1 | 6.0 | 3.0 | 2.6 | | | 3.3 | 3.1 |
| *Miami Springs* | | | | | | | | |
| Summer Trips | 290 | 712 | 2,768 | *A/* | 792 | 408 | | 1,256 |
| Winter Trips | 478 | 1,064 | 3,242 | | 946 | 462 | | 1,510 |
| Percent Summer | 0.5 | 0.7 | 8.6 | | 0.7 | 0.9 | | 5.7 |
| Percent Winter | 0.4 | 0.9 | 8.1 | | 0.7 | 0.8 | | 5.2 |
| *Airport* | | | | | | | | |
| Summer Trips | 1,124 | 2,736 | 2,726 | 242 | 1,031 | 412 | 1,256 | |
| Winter Trips | 2,549 | 3,234 | 3,029 | 228 | 1,781 | 911 | 1,510 | |
| Percent Summer | 1.8 | 2.6 | 8.4 | 2.4 | 1.0 | 0.4 | 10.7 | |
| Percent Winter | 2.3 | 2.7 | 7.5 | 1.9 | 1.4 | 0.7 | 10.8 | |

*A/* Insufficient Trips

## Table III

### Comparison of Origins and Destinations by Zones

| Zone | Origins | | | | Destinations | | | |
|---|---|---|---|---|---|---|---|---|
| | Number in Summer | Number in Winter | Percent of Total Summer Origins | Percent of Total Winter Origins | Number in Summer | Number in Winter | Percent of Total Summer Destinations | Percent of Total Winter Destinations |
| 011 | 743 | 793 | 0.128 | 0.093 | 711 | 837 | 0.123 | 0.098 |
| 012 | 976 | 1,594 | 0.168 | 0.187 | 981 | 1,530 | 0.169 | 0.180 |
| 013 | 989 | 1,018 | 0.171 | 0.119 | 966 | 965 | 0.167 | 0.113 |
| 014 | 1,276 | 1,845 | 0.220 | 0.217 | 1,304 | 1,866 | 0.225 | 0.219 |
| 015 | 1,600 | 2,392 | 0.276 | 0.281 | 1,705 | 2,374 | 0.294 | 0.279 |
| 016 | 1,086 | 1,405 | 0.187 | 0.165 | 1,153 | 1,377 | 0.199 | 0.162 |
| 017 | 2,872 | 4,335 | 0.496 | 0.509 | 2,996 | 4,320 | 0.517 | 0.507 |
| 018 | 1,690 | 2,713 | 0.292 | 0.318 | 1,740 | 2,644 | 0.300 | 0.310 |
| 019 | 1,557 | 2,369 | 0.269 | 0.278 | 1,700 | 2,348 | 0.293 | 0.276 |
| 021 | 1,011 | 927 | 0.175 | 0.109 | 992 | 908 | 0.171 | 0.107 |
| 022 | 690 | 1,084 | 0.119 | 0.127 | 693 | 1,060 | 0.120 | 0.124 |
| 023 | 932 | 1,089 | 0.161 | 0.128 | 971 | 1,092 | 0.168 | 0.128 |
| 024 | 763 | 1,016 | 0.132 | 0.119 | 731 | 1,018 | 0.126 | 0.119 |
| 025 | 868 | 1,117 | 0.150 | 0.131 | 856 | 1,098 | 0.148 | 0.129 |
| 026 | 454 | 739 | 0.078 | 0.087 | 468 | 701 | 0.081 | 0.082 |
| 027 | 783 | 968 | 0.135 | 0.114 | 768 | 841 | 0.133 | 0.099 |
| 028 | 1,069 | 1,288 | 0.185 | 0.151 | 1,100 | 1,294 | 0.190 | 0.152 |
| 029 | 807 | 1,355 | 0.139 | 0.159 | 901 | 1,356 | 0.156 | 0.159 |
| 031 | 1,240 | 1,955 | 0.214 | 0.229 | 1,286 | 1,928 | 0.222 | 0.226 |
| 032 | 1,523 | 1,618 | 0.263 | 0.190 | 1,598 | 1,566 | 0.276 | 0.184 |
| 033 | 1,528 | 2,285 | 0.264 | 0.268 | 1,492 | 2,134 | 0.258 | 0.251 |
| 034 | 1,264 | 1,366 | 0.218 | 0.160 | 1,232 | 1,366 | 0.213 | 0.160 |
| 041 | 1,643 | 3,112 | 0.284 | 0.365 | 1,597 | 3,030 | 0.276 | 0.356 |
| 042 | 3,592 | 3,983 | 0.620 | 0.468 | 3,744 | 4,139 | 0.646 | 0.486 |
| 043 | 1,138 | 1,642 | 0.196 | 0.193 | 1,162 | 1,612 | 0.201 | 0.189 |
| 044 | 1,938 | 3,135 | 0.335 | 0.368 | 2,059 | 3,050 | 0.355 | 0.358 |
| 045 | 12,949 | 17,559 | 2.235 | 2.061 | 13,797 | 18,065 | 2.382 | 2.121 |
| 046 | 2,923 | 4,294 | 0.505 | 0.504 | 3,005 | 4,256 | 0.519 | 0.500 |
| 047 | 1,774 | 3,308 | 0.306 | 0.388 | 1,871 | 3,379 | 0.323 | 0.397 |
| 048 | 6,261 | 9,989 | 1.081 | 1.162 | 7,021 | 10,342 | 1.212 | 1.214 |
| 049 | 559 | 1,060 | 0.096 | 0.124 | 526 | 1,311 | 0.091 | 0.154 |
| 111 | 726 | 1,821 | 0.125 | 0.214 | 933 | 1,703 | 0.161 | 0.200 |
| 112 | 397 | 969 | 0.069 | 0.114 | 456 | 988 | 0.079 | 0.116 |
| 113 | 1,450 | 2,475 | 0.250 | 0.291 | 1,408 | 2,496 | 0.243 | 0.293 |
| 121 | 1,503 | 3,246 | 0.259 | 0.381 | 1,690 | 3,338 | 0.292 | 0.392 |
| 122 | 9,404 | 10,552 | 1.623 | 1.239 | 9,425 | 10,393 | 1.627 | 1.220 |
| 123 | 3,051 | 5,040 | 0.527 | 0.592 | 3,100 | 4,980 | 0.535 | 0.585 |
| 131 | 3,121 | 5,035 | 0.539 | 0.591 | 3,251 | 4,926 | 0.561 | 0.578 |
| 132 | 2,094 | 3,330 | 0.361 | 0.391 | 2,174 | 3,378 | 0.375 | 0.397 |
| 211 | 12,295 | 14,650 | 2.122 | 1.720 | 12,487 | 14,427 | 2.155 | 1.694 |
| 212 | 11,278 | 13,229 | 1.947 | 1.553 | 11,389 | 13,437 | 1.966 | 1.577 |
| 213 | 7,176 | 10,969 | 1.239 | 1.287 | 7,388 | 11,023 | 1.275 | 1.294 |
| 221 | 3,883 | 5,196 | 0.670 | 0.610 | 3,919 | 5,278 | 0.676 | 0.620 |
| 222 | 5,087 | 6,748 | 0.878 | 0.792 | 5,071 | 6,857 | 0.875 | 0.805 |

Table III, *continued*

| Zone | Origins | | | | Destinations | | | |
|---|---|---|---|---|---|---|---|---|
| | Number in Summer | Number in Winter | Percent of Total Summer Origins | Percent of Total Winter Origins | Number in Summer | Number in Winter | Percent of Total Summer Destinations | Percent of Total Winter Destinations |
| 231 | 6,784 | 8,824 | 1.171 | 1.036 | 6,961 | 8,700 | 1.202 | 1.021 |
| 232 | 4,198 | 5,799 | 0.725 | 0.681 | 4,229 | 5,766 | 0.730 | 0.677 |
| 233 | 12,245 | 15,370 | 2.114 | 1.804 | 12,375 | 15,608 | 2.136 | 1.832 |
| 311 | 4,797 | 7,884 | 0.828 | 0.925 | 4,887 | 7,809 | 0.844 | 0.917 |
| 312 | 6,510 | 8,700 | 1.124 | 1.021 | 6,477 | 8,537 | 1.118 | 1.002 |
| 313 | 13,577 | 19,376 | 2.344 | 2.274 | 13,454 | 19,215 | 2.322 | 2.256 |
| 314 | 7,892 | 13,764 | 1.362 | 1.616 | 7,988 | 13,622 | 1.379 | 1.599 |
| 315 | 4,211 | 5,925 | 0.727 | 0.696 | 4,201 | 6,125 | 0.725 | 0.719 |
| 316 | 9,179 | 12,497 | 1.584 | 1.467 | 9,089 | 12,359 | 1.569 | 1.451 |
| 317 | 7,469 | 9,112 | 1.289 | 1.070 | 7,439 | 8,993 | 1.284 | 1.056 |
| 318 | 5,962 | 6,817 | 1.029 | 0.800 | 6,007 | 6,855 | 1.037 | 0.805 |
| 321 | 8,168 | 10,103 | 1.410 | 1.186 | 8,364 | 10,208 | 1.444 | 1.198 |
| 322 | 12,689 | 17,430 | 2.190 | 2.046 | 12,877 | 17,405 | 2.223 | 2.043 |
| 323 | 11,132 | 15,001 | 1.922 | 1.761 | 11,272 | 15,081 | 1.946 | 1.770 |
| 324 | 6,773 | 10,073 | 1.169 | 1.182 | 6,746 | 9,961 | 1.164 | 1.169 |
| 325 | 10,032 | 16,434 | 1.732 | 1.929 | 10,074 | 16,300 | 1.739 | 1.913 |
| 326 | 6,463 | 8,216 | 1.116 | 0.964 | 6,602 | 8,262 | 1.140 | 0.970 |
| 327 | 6,993 | 8,882 | 1.207 | 1.043 | 7,069 | 8,973 | 1.220 | 1.053 |
| 328 | 1,937 | 2,608 | 0.334 | 0.306 | 1,935 | 2,587 | 0.334 | 0.304 |
| 411 | 2,283 | 3,334 | 0.394 | 0.391 | 2,387 | 3,394 | 0.412 | 0.398 |
| 412 | 7,517 | 12,382 | 1.298 | 1.453 | 7,545 | 12,174 | 1.302 | 1.429 |
| 413 | 13,779 | 21,396 | 2.378 | 2.512 | 13,717 | 22,208 | 2.368 | 2.607 |
| 414 | 9,973 | 15,243 | 1.721 | 1.789 | 10,305 | 15,008 | 1.779 | 1.762 |
| 421 | 9,245 | 13,044 | 1.596 | 1.531 | 9,381 | 12,117 | 1.619 | 1.422 |
| 422 | 6,641 | 10,846 | 1.146 | 1.273 | 6,708 | 10,804 | 1.158 | 1.268 |
| 423 | 3,160 | 4,747 | 0.545 | 0.557 | 3,207 | 4,607 | 0.554 | 0.541 |
| 424 | 3,350 | 4,761 | 0.578 | 0.559 | 3,288 | 4,692 | 0.568 | 0.551 |
| 425 | 7,597 | 10,329 | 1.311 | 1.212 | 7,702 | 10,289 | 1.329 | 1.208 |
| 511 | 4,982 | 7,307 | 0.860 | 0.858 | 4,937 | 6,897 | 0.852 | 0.810 |
| 512 | 3,638 | 7,326 | 0.628 | 0.860 | 3,721 | 7,452 | 0.642 | 0.875 |
| 513 | 3,384 | 3,718 | 0.584 | 0.436 | 2,967 | 3,703 | 0.512 | 0.435 |
| 521 | 1,016 | 1,560 | 0.175 | 0.183 | 1,107 | 1,492 | 1.911 | 0.175 |
| 522 | 1,093 | 2,697 | 0.189 | 0.317 | 1,213 | 2,704 | 0.209 | 0.317 |
| 523 | 5,173 | 6,111 | 0.893 | 0.717 | 5,567 | 6,153 | 0.961 | 0.722 |
| 524 | 3,160 | 4,118 | 0.545 | 0.483 | 3,121 | 4,223 | 0.539 | 0.496 |
| 525 | 2,898 | 4,295 | 0.500 | 0.504 | 2,838 | 4,243 | 0.490 | 0.498 |
| 611 | 5,007 | 6,201 | 0.864 | 0.728 | 5,055 | 6,146 | 0.873 | 0.721 |
| 612 | 8,081 | 11,310 | 1.395 | 1.328 | 7,913 | 10,959 | 1.366 | 1.286 |
| 613 | 4,618 | 7,854 | 0.797 | 0.922 | 4,628 | 7,785 | 0.799 | 0.914 |
| 614 | 9,091 | 18,833 | 1.569 | 2.211 | 9,133 | 18,562 | 1.576 | 2.179 |
| 621 | 9,993 | 13,922 | 1.725 | 1.634 | 9,852 | 13,784 | 1.701 | 1.618 |
| 622 | 8,432 | 11,434 | 1.455 | 1.342 | 8,487 | 11,490 | 1.465 | 1.349 |
| 623 | 17,828 | 25,991 | 3.077 | 3.051 | 17,974 | 26,142 | 3.103 | 3.069 |
| 624 | 15,282 | 20,301 | 2.638 | 2.383 | 15,468 | 20,044 | 2.670 | 2.353 |
| 625 | 6,996 | 8,374 | 1.208 | 0.983 | 7,095 | 8,451 | 1.225 | 0.992 |
| 626 | 2,501 | 4,124 | 0.432 | 0.484 | 2,556 | 4,146 | 0.441 | 0.487 |

Table III, *continued*

| Zone | Origins | | | | Destinations | | | |
|---|---|---|---|---|---|---|---|---|
| | Number in Summer | Number in Winter | Percent of Total Summer Origins | Percent of Total Winter Origins | Number in Summer | Number in Winter | Percent of Total Summer Destinations | Percent of Total Winter Destinations |
| 627 | 7,200 | 8,548 | 1.243 | 1.003 | 7,163 | 8,522 | 1.236 | 1.000 |
| 628 | 7,350 | 10,050 | 1.269 | 1.180 | 7,387 | 9,803 | 1.275 | 1.151 |
| 711 | 5,354 | 6,964 | 0.924 | 0.817 | 5,157 | 6,957 | 0.890 | 0.817 |
| 712 | 2,917 | 3,418 | 0.504 | 0.401 | 2,915 | 3,368 | 0.503 | 0.395 |
| 713 | 11,286 | 14,271 | 1.948 | 1.675 | 11,424 | 13,218 | 1.972 | 1.552 |
| 714 | 4,170 | 5,532 | 0.720 | 0.649 | 4,152 | 5,463 | 0.717 | 0.641 |
| 715 | 7,859 | 12,257 | 1.357 | 1.439 | 7,993 | 12,261 | 1.380 | 1.439 |
| 721 | 4,610 | 6,022 | 0.796 | 0.707 | 4,623 | 5,949 | 0.798 | 0.698 |
| 722 | 3,420 | 4,416 | 0.590 | 0.518 | 3,516 | 4,369 | 0.607 | 0.513 |
| 723 | 12,158 | 15,982 | 2.099 | 1.876 | 12,647 | 15,901 | 2.183 | 1.867 |
| 811 | 4,613 | 4,481 | 0.796 | 0.526 | 4,637 | 4,506 | 0.800 | 0.529 |
| 812 | 576 | 807 | 0.099 | 0.106 | 561 | 776 | 0.097 | 0.091 |
| 813 | 1,145 | 969 | 0.198 | 0.114 | 1,256 | 1,039 | 0.217 | 0.122 |
| 821 | 2,484 | 6,779 | 0.429 | 0.796 | 2,676 | 6,844 | 0.462 | 0.803 |
| 822 | 5,079 | 5,822 | 0.877 | 0.683 | 4,988 | 5,780 | 0.861 | 0.678 |
| 823 | 4,439 | 5,617 | 0.766 | 0.659 | 4,460 | 5,632 | 0.770 | 0.661 |
| 9101 | 75 | 2,265 | 0.013 | 0.266 | 43 | 2,234 | 0.007 | 0.262 |
| 9102 | 11,359 | 18,371 | 1.961 | 2.156 | 11,922 | 20,253 | 2.058 | 2.377 |
| 9103 | 8,951 | 14,900 | 1.541 | 1.749 | 9,102 | 16,075 | 1.571 | 1.887 |
| 9104* | 8,667 | 1,959 | 1.496 | 0.230 | 9,109 | 2,139 | 1.572 | 0.251 |
| 9105 | 1,115 | 3,250 | 0.192 | 0.382 | 1,160 | 3,502 | 0.200 | 0.411 |
| 9106 | 1,328 | 1,786 | 0.229 | 0.210 | 1,289 | 1,773 | 0.222 | 0.208 |
| 9107 | 890 | 1,199 | 0.154 | 0.141 | 806 | 1,313 | 0.139 | 0.154 |
| 9108 | 475 | 437 | 0.082 | 0.051 | 415 | 421 | 0.072 | 0.049 |
| 9109 | 2,420 | 3,085 | 0.418 | 0.362 | 2,537 | 3,242 | 0.438 | 0.381 |
| 9110 | 4,182 | 5,829 | 0.722 | 0.684 | 4,268 | 5,661 | 0.737 | 0.665 |
| 9111 | 1,501 | 1,744 | 0.259 | 0.205 | 1,793 | 1,824 | 0.309 | 0.214 |
| 9112 | 266 | 790 | 0.046 | 0.093 | 273 | 704 | 0.047 | 0.083 |
| 9113 | 798 | 1,496 | 0.138 | 0.176 | 884 | 1,562 | 0.153 | 0.183 |
| 9114 | — | — | — | — | — | — | — | — |
| 9115 | — | — | — | — | — | — | — | — |
| 9116* | — | 7,122 | — | 0.836 | — | 6,908 | — | 0.811 |
| 9117* | — | 3,724 | — | 0.437 | — | 3,604 | — | 0.423 |
| 9118* | — | 3,625 | — | 0.426 | — | 3,931 | — | 0.461 |
| Other 9000s | 8,940 | 9,090 | 1.543 | 1.569 | 26,264 | 25,702 | 3.083 | 3.017 |

* 9104 was further subdivided for the winter cycle.

At this point in the analyses it appeared logical to assume that there had been no material change in origin and destination pattern between summer and winter even though the total trips per twenty-four hours had increased from 579,330 to 851,890, or 47 percent. No effort was made to make a complete zone to zone comparison of trip volumes between summer and winter to prove this assumption. A

number of zone to zone comparisons were made, however, in which the summer movement was expanded by a factor of 1.47 and then compared to the winter movement for the same pairs of zones. It indicated quite clearly that the summer origin and destination table could have been uniformly expanded by 47 percent and a usable winter origin and destination table would have resulted. Table 4 shows a number of such zone to zone movements picked at random from the origin and destination tables which illustrate this fact.

### Twin Studies Give Base for Research

To this point in the analysis little had actually been accomplished except to prove that the winter origin and destination survey had not been needed and it appeared that a great deal of time and money had been wasted. In self-defense the writers of this article, and their associates, began thinking about the factors which influence the travel habits of individuals within an urban area to make sure we had not overlooked some fact that could have told us in advance that the winter study was unnecessary. As the thinking progressed it became evident that the winter study had been a necessary though costly operation. It also became evident that the twin studies provided an excellent base for research into the field of urban travel habits. Since Florida, and most other states have just begun to tackle the urban problem, such research could be most helpful in conducting and perpetuating studies in other cities of the nation.

Unfortunately, limited personnel and the pressure of routine tasks left little time to delve into the wealth of data available. The writers therefore welcomed this opportunity to offer to the readers of *Traffic Quarterly*, who have a taste for research, a chance to work and think with us on this problem.

In the following paragraphs appear some of the ideas and theories that resulted from study of the two surveys. Some have no doubt been advanced by others and some may not withstand the weight of subsequently discovered facts. However, taken together, they appear to offer a possible means of keeping origin and destination surveys current, and eventually of developing complete origin and destination data by applying mathematical formulas to readily available data that are easier to obtain than the trip data.

Table IV

SUMMER ORIGINS AND DESTINATIONS MULTIPLIED BY A COMMON FACTOR AND COMPARED WITH WINTER ORIGINS AND DESTINATIONS

| | Origins | | | Destinations | | |
|---|---|---|---|---|---|---|
| Zone | Number in Summer | Summer X 1.471 | Number in Winter | Number in Summer | Summer X 1.471 | Number in Winter |
| 017 | 2,872 | 4,225 | 4,335 | 2,996 | 4,407 | 4,320 |
| 018 | 1,690 | 2,486 | 2,713 | 1,740 | 2,560 | 2,644 |
| 024 | 763 | 1,122 | 1,016 | 731 | 1,075 | 1,018 |
| 025 | 868 | 1,277 | 1,117 | 856 | 1,259 | 1,098 |
| 031 | 1,240 | 1,824 | 1,955 | 1,286 | 1,892 | 1,928 |
| 033 | 1,528 | 2,248 | 2,285 | 1,492 | 2,195 | 2,134 |
| 043 | 1,138 | 1,674 | 1,642 | 1,162 | 1,709 | 1,612 |
| 046 | 2,923 | 4,300 | 4,294 | 3,005 | 4,420 | 4,256 |
| 048 | 6,261 | 9,210 | 9,989 | 7,021 | 10,328 | 10,342 |
| 123 | 3,051 | 4,488 | 5,040 | 3,100 | 4,560 | 4,980 |
| 131 | 3,121 | 4,591 | 5,035 | 3,251 | 4,782 | 4,926 |
| 132 | 2,094 | 3,080 | 3,330 | 2,174 | 3,198 | 3,378 |
| 213 | 7,176 | 10,556 | 10,969 | 7,388 | 10,868 | 11,023 |
| 313 | 13,577 | 19,971 | 19,376 | 13,454 | 19,791 | 19,215 |
| 315 | 4,211 | 6,194 | 5,925 | 4,201 | 6,180 | 6,125 |
| 324 | 6,773 | 9,963 | 10,073 | 6,746 | 9,923 | 9,961 |
| 328 | 1,937 | 2,849 | 2,608 | 1,935 | 2,846 | 2,587 |
| 411 | 2,283 | 3,358 | 3,334 | 2,387 | 3,511 | 3,394 |
| 414 | 9,973 | 14,670 | 15,243 | 10,305 | 15,159 | 15,008 |
| 423 | 3,160 | 4,648 | 4,747 | 3,207 | 4,717 | 4,607 |
| 424 | 3,350 | 4,928 | 4,761 | 3,288 | 4,837 | 4,692 |
| 511 | 4,982 | 7,329 | 7,307 | 4,937 | 7,262 | 6,897 |
| 521 | 1,016 | 1,495 | 1,560 | 1,107 | 1,628 | 1,492 |
| 525 | 2,898 | 4,263 | 4,295 | 2,838 | 4,175 | 4,243 |
| 612 | 8,081 | 11,887 | 11,310 | 7,913 | 11,640 | 10,959 |
| 623 | 17,828 | 26,225 | 25,991 | 17,974 | 26,440 | 26,142 |
| 628 | 7,350 | 10,812 | 10,050 | 7,387 | 10,866 | 9,803 |
| 715 | 7,859 | 11,561 | 12,257 | 7,993 | 11,758 | 12,261 |
| 812 | 576 | 847 | 807 | 561 | 825 | 776 |
| 813 | 1,145 | 1,684 | 969 | 1,256 | 1,848 | 1,039 |
| 823 | 4,439 | 6,530 | 5,617 | 4,460 | 6,561 | 5,632 |
| 9102 | 11,359 | 16,709 | 18,371 | 11,922 | 17,537 | 20,253 |
| 9103 | 8,951 | 13,167 | 14,900 | 9,102 | 13,389 | 16,075 |
| 9104 | 8,667 | 12,749 | 16,430 | 9,109 | 13,399 | 16,582 |
| 9106 | 1,328 | 1,953 | 1,786 | 1,289 | 1,896 | 1,773 |
| 9109 | 2,420 | 3,560 | 3,085 | 2,537 | 3,732 | 3,242 |

## Trip Generation and Drawing Power

A zone may be considered to exert two forces on the travel patterns of an area. First, it is the source from which trips start. In this sense it *generates* trips and can therefore be considered as having a *genera-*

*tive* influence on the trip pattern. Second, it draws trips to it from other zones, somewhat in proportion to its ability to satisfy the needs for which trips are made. This ability to draw trips could, for want of a better term, be considered as its *magnetic* influence on the trip pattern. The number of trips originating in a zone with a trip purpose other than "to home," is a quantitative measure of its generative ability, while the number of trips destined to a zone with a trip purpose other than "to home," is a like measure of its magnetic power.

The generative forces influencing the number of trips that may be anticipated to emanate from a zone would at least include the following:

1. Population of zone.
2. Geographic location.
3. Economic level.

Anyone with experience in traffic can readily accept the fact that the number of trips generated in an area is related to the number of persons living within that area. If the definitions for generative and magnetic forces are temporarily accepted for the purposes of clarification, then the above statement is true because such areas as the central business district, shopping centers and recreational areas, where relatively few people live, would no longer be considered as large generators of traffic but would be referred to as large magnetic forces, drawing the generated traffic to them. Population, therefore, is a vital factor in determining the generative powers of a zone.

Conversely it is evident that two zones with approximately the same population do not necessarily generate the same number of trips. Factors other than population are obviously involved. It is probable that the zone's geographic location has considerable bearing on its generative ability. For example, people living close to a grocery store may make several trips each week to buy groceries while those who must travel long distances will buy a week's supply at a time. Also, considerable evidence supports the belief that the economic level of a zone has a decided bearing on the number of trips made by an individual. Both the very rich and the very poor show a common apathy toward travel; probably because the very rich can think of nothing they want, and the very poor can think of nothing they can afford to buy.

No doubt other factors influence the generative powers of a zone.

The three listed above, however, offer a fertile field for research. Once their interrelationships are understood it is probable that generated trips could be predicated for any area from data available through the Bureau of Census.

### Factors Influencing Generated Trips

All generated trips have a purpose whether it be work, business, shopping, recreational, or otherwise. Even the desire to get away from home and go for a ride has an underlying recreational purpose as its stimulus. For most trip purposes, numerous areas or zones compete with each other to draw the generated trips. For example, numerous shopping and recreational areas exist in the modern city and there are reasons why, for each generated trip, one area is selected in preference to another. Progressive store owners and marketing analysts already know many facts concerning their drawing power within a given trade area that would be helpful to the traffic engineer. The relationship between areas where people live and where they work has already been studied somewhat superficially. Again, within broad occupational groupings, there appears to be a pattern that could be understood and measured.

Factors other than "purpose of trip" also affect the magnetic powers of an area. Of great importance is its relative degree of accessibility. In most cities the central business district would draw far more traffic if it were not so congested and if adequate parking space were available. To a lesser degree, the congestion factor would play a part in determining the drawing power of any zone for any appropriate trip purpose. Existing parking surveys should provide sufficient data in the downtown area to give some quantitative measure of this factor. In other areas additional data would no doubt be necessary.

A third factor is the land-use of the zone. Obviously a zone having no recreational facilities can draw few recreational trips. It is also obvious that a thousand square feet of floor space in a furniture store will not draw as many trips as will a thousand square feet in a dime store. Unless there is commercial or industrial development within the zone only a few workers will be needed. This factor is closely related to still another factor which might be described as the variety

of available services within a concentrated area. A particular zone might have its magnetic influence greatly enhanced by the fact that more than one trip purpose could be satisfied by a single trip.

Here are four factors which, when properly measured and combined, should give a reasonably accurate indication of the magnetic influence of a zone. It is further believed that existing origin-destination and parking surveys when correlated with data collected by the Bureau of the Census, land use and other local economic information, would form a sufficient basis to determine the feasibility of this approach to the development of the generative and magnetic potentials of a zone.

### Finding the Traffic Pattern

One vital item is missing. Assuming that the generative and magnetic abilities of all the zones can be determined, then how can they be linked together to obtain the traffic pattern? The answer to that question may lie in determining the time required to make a trip to each of the zones involved. For example, let us assume that Zone A generates 100 shopper trips each day. In the interest of simplicity let us assume further that these trips can be satisfied at Zone B and at Zone C. Zone B has a magnetic index of two while Zone C has a magnetic index of only one because of other factors such as inadequate parking and congestion. If Zone B and Zone C were an equal time interval away from Zone A, then one might expect that Zone B would draw twice as many of the Zone A trips as would Zone C.

However, if Zone B were a much greater time interval than Zone C from Zone A, then Zone C should draw more of Zone A trips even though it is a less desirable place to shop. Time is suggested here as the final linkage factor because it has been established that time-saving is presently the best basis for determining the distribution of trips between alternate routes when the points of origin and destination are the same. It is therefore reasonable to assume that savings in time might give a fairly accurate distribution of movements between zones once the other factors have been accurately measured because drivers appear to be more aware of time than they are of distance.

A few years ago such a research project as proposed here would

have been extremely difficult and cumbersome to complete because of the tremendous number of mathematical calculations and manipulations of data involved. Today, the punch card and the electronic computor can perform repetitious calculations and manipulations with fantastic speed and the use of this equipment can be obtained through contracts with organizations specializing in such work at very reasonable cost.

### Old Data Usable by Redundancy

In considering appropriate methods for keeping the Miami survey data current and in studying the similarity of traffic patterns of the two surveys, it became strikingly evident that even with a doubling of population a remarkable degree of repetition in the facts was obtained. In seeking a term to express this repetition, the word "redundant" seemed most appropriate. In applying the idea of redundancy to travel patterns, suppose an origin and destination survey were conducted in a city and then redone a month later. Further, assume that the two surveys were both based on 100 percent samples. Then, aside from differences due to chance variations, there would probably be some permanent, though minute, changes in the patterns. As the time increment between the two surveys was increased, the permanent changes in pattern should also increase. In other words the redundancy of the data for the two surveys taken one month apart would be very high, but as the time interval between the studies increased, decrease in redundance would result.

This leads to a rather interesting hypothesis. It is possible that old origin and destination data in existence may be brought up to date by assuming that the vast majority of the data remains the same so far as patterns are concerned. It could further be assumed that significant changes in traffic patterns are created only by changes in land use of the area itself. Major area changes of both a generative and magnetic character could be cordoned and studied separately and the rest of the area could be assumed to be largely redundant in pattern although probably different quantitatively.

In general, land use changes slowly. The observable sequence of creation, growth, stabilization, and final possible decay of individual generative and magnetic areas is not one of very great velocity.

Where this sequence is accelerated, the causative factors, at least in gross fashion, are apparent. Furthermore, geographical considerations, zoning regulations, sociological, and economic factors help to define the character of changes that do take place. Conversely, in a city with a strong master plan, elements causing change can be so controlled as to create predictable changes in land use and thus serve as a means of reliability in predicting traffic patterns well into the future.

It is relatively easy for informed people to ask pertinent questions regarding traffic. It is somewhat more difficult to delineate appropriate fields for research where the answers may be found. It is next to impossible to find the time, money, and qualified personnel with which to carry on the search for additional knowledge. Unless a large and responsible segment of the traffic engineering profession can overcome its preoccupation with traffic signals, one-way streets, and painting lines on pavements, and really seek to understand the travel habits and desires of the traveling public through a vastly expanded research program, there is little reason to hope that much will be accomplished in the years ahead.

# Washington's Snow Traffic Program

GEORGE E. KENEIPP

*Mr. Keneipp has been for eight years director of vehicles and traffic for the District of Columbia. In 1927 he joined the staff of the District division of the American Automobile Association as editor of the District edition of the "American Motorist," later becoming manager of the D. C. division. From 1934 to 1946 he was affiliated with the Keystone Automobile Club as manager of the Washington office, and subsequently as manager of the southern division which combined the District of Columbia and Maryland. Mr. Keneipp in 1949 was appointed chairman of the committee on engineering and vehicle inspection of the American Association of Motor Vehicle Administrators in recognition of his work in this field. Last year he was elected president of the Eastern Conference of Motor Vehicle Administrators.*

WASHINGTON'S Snow Emergency Traffic Program was born on Friday, December 14, 1951 when an unheralded three-inch snowfall brought about the worst transportation and communication tie-up in the city's history. The three inches of snow knocked Greater Washington, which had been promised a fair day by the weather man, off its feet.

What began as rain later developed into sleet and snow so that by noon the city was covered with a thin coating of ice. By early afternoon all streets were coated with about two inches of ice, and sleet continued to fall. By three o'clock most of the federal government departments, which constitute Washington's largest industry, decided that conditions were hazardous and released their employees simultaneously. They found themselves marooned in the traffic jam that extended block on block.

Delays were counted in hours; it took as long as ten hours for some people to get home. Thousands more were stranded at streetcar and bus stops, unable to find transportation home. Taxicabs were at a premium. Buses from other cities found it difficult to enter Washington and outbound buses to leave. Police switchboards were flooded with hundreds of calls about minor accidents. The telephone company's dial system was tied up for more than two hours. Am-

December 14, 1951, was the worst traffic tie-up in Washington's, D. C. history.

Unprepared motorists, unable to negotiate hills in Washington, D.C., skid to positions effectively blocking traffic.

bulances unable to move through car-to-car traffic were out of service in many instances.

The inexperience of many motorists in driving over snowy, slushy and icy roads paralyzed most of the city's traffic. It must be remembered that many of the motorists had never even seen snow. Much of the trouble was caused by a policy of "slam it into low and spin the wheels." Although the District's sanding and snow removal agencies were mobilized rapidly, the continued sleet made the sand ineffective. And the ice was so hard it could not be plowed. Salt (either sodium or calcium chloride) is not used as heavily as in other cities to combat icy conditions in Washington because its use results in short circuiting of the underground third rail of the transit system.

The early simultaneous dismissal of the federal departments swamped the city's streetcar and bus system which was unable to cope with the situation on such short notice. The vast majority of passenger cars and trucks were unequipped with skid chains or snow tires. Many who attempted to drive their cars were unable to negotiate the hills and their cars skidded to positions which effectively blocked traffic. Consequently, it was well into the night before conditions took a turn for the better and it took most of the night and the next day to clear the streets of stalled vehicles. Traffic had never been so completely snarled in the memory of Washington residents. Since few residents could recall such conditions, it is fair to state that the city was caught unprepared.

### The Commissioners' Snow Emergency Committee

Naturally the complete paralysis of an important city like Washington caused plenty of comment, mostly unfavorable to city officials. A Congressman from one of the southern states, who had been out of town on Friday, called me on his return to ask what had happened. I replied that Washington was filled with people from the South, from states like his, who were "so taken aback by the heavy snowfall, that they completely fouled us up." The Congressman laughed and agreed it was probably true.

The District of Columbia is governed by a three-man board of commissioners appointed by the President. The following Tues-

day, December 18, the commissioners called an emergency meeting of District officials and citizens concerned—police, traffic, street cleaning, snow removal, public utilities, as well as representatives of the streetcar and bus transit companies, automobile clubs and trucking concerns—and handed them the assignment of considering "means of alleviating traffic congestion resulting from hazardous street conditions caused by snow and ice." This was not to be just another committee; they were ordered to report back within forty-eight hours. The snow emergency committee did just that—with a specific set of recommendations. All of these were approved on the spot by the commissioners and a new snow emergency regulation became effective immediately on December 20. This set something of a record for regulatory action.

At its December 18 meeting, the committee dug into the reasons for the historic paralysis of the nation's capital, with virtually every important arterial street clogged by stalled and abandoned vehicles. There were lessons to be learned from that storm, and the members of the committee were determined that not again should Washington be caught by a paralyzing snow storm in a state of almost complete unpreparedness.

The conditions leading to the city's paralysis were analyzed as follows:

1. The lack of a snow emergency plan to combat the snow and ice conditions on the road.

2. The simultaneous early release of government workers before all main roads had been sanded and without sufficient notice for bus and streetcar schedules to be changed.

3. The unfamiliarity of many motorists with driving under hazardous winter conditions.

4. The inability of the city's sanitation crews to remove snow because of stalled and abandoned vehicles' impeding their equipment.

### Street Use Limited in Emergency

During its six-hour meeting in search of an effective plan to prevent recurrence of the snow paralysis, the committee studied many drastic proposals. These included limiting main roads to vehicles with chains; keeping all automobiles off streetcar tracks; creating a pool

of private tow trucks; adopting the "Baltimore Plan" of barring all but emergency vehicles and public transportation from streets; requiring each motorist to carry a bag of sand and scatter it on inclines.

The regulation finally adopted on the basis of the committee report provided the following solution to Condition One:

> "Whenever snow, sleet or freezing rain is falling and the Director of Vehicles and Traffic finds that such snow, sleet or freezing rain is causing slippery or hazardous conditions which may lead to serious traffic congestion on streets of the District, the Director of Vehicles and Traffic may declare an emergency and until he has declared such emergency terminated, no vehicle, other than the type described in this Section, shall operate on any of the following streets during such period of emergency unless such vehicles are equipped with effective skid chains or effective snow-tread tires; provided, however, that persons with vehicles not equipped with such skid chains or snow-tread tires may operate on the following streets for the sole purpose of leaving a public or private driveway, parking lot, garage or curb parking space, and then only to the nearest intersection where a right turn is permitted and provided further that nothing herein shall prevent the crossing by any vehicle of any street listed herein, at an intersection."

The order then listed some fifty-six major streets and arteries upon which motorists could not operate during the emergency without skid chains or snow-tread tires. It also listed the type of vehicles exempt from compliance. They were:

Public transit vehicles; vehicles transporting fuel oil, coal, gasoline, and motor oils, foods, milks, medicines and surgical instruments; emergency vehicles of public service corporations; ambulances and vehicles carrying sick or injured persons; vehicles engaged in snow removal operations or sanding streets; undertakers' vehicles and funerals; vehicles carrying passengers for hire; tow trucks; newsprint and newspaper vehicles; physicians responding to sick calls; vehicles carrying U. S. Mail; Federal or District Government vehicles, and vehicles carrying foreign diplomats; and vehicles carrying members of the clergy.

### Control of Dismissal Hours

To counteract the staggering effect of Condition Two, the simultaneous early dismissal of government employees, the committee recommended reaching an understanding with the Federal Person-

nel Council. Committee representatives entered into a series of discussions with the council, which represented all federal agencies. A plan was finally developed calling for the orderly dismissal of employees so many hours ahead of their normal quitting time. Working hours for federal agencies were already staggered between 7:30 and 9:30 a.m. and 3:30 and 5:30 p.m. Consequently, if a dismissal were ordered for two hours ahead of closing time, the interval of staggered dismissal would be retained.

The Capital Transit Company made it clear that it would be impossible to mobilize its personnel and equipment on very short notice. However, the committee felt it would be better to crowd the workers into regular off-peak hour equipment and get them started home even under bad conditions, rather than keep them on with conditions steadily becoming worse.

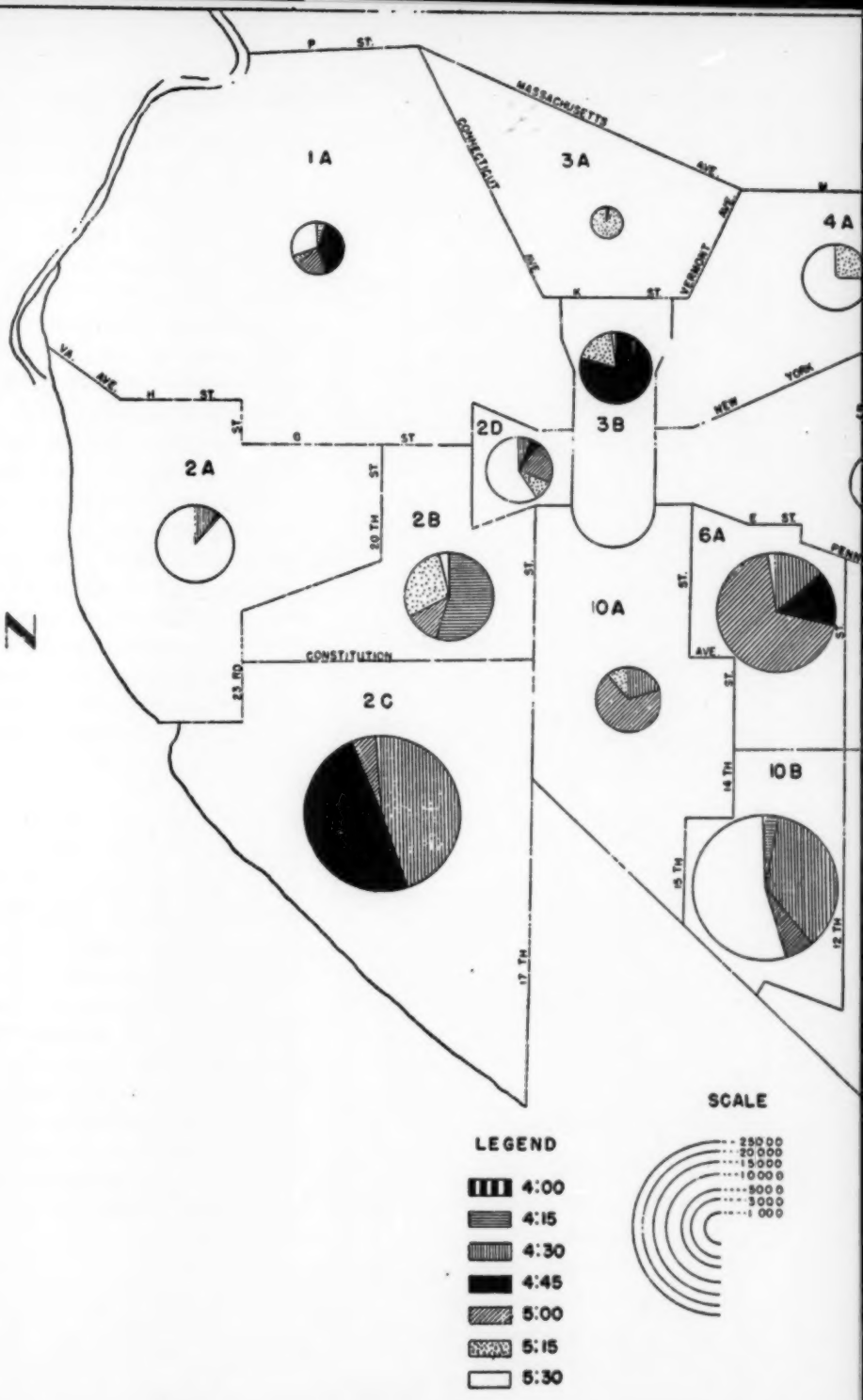
A memorandum on White House stationery dated January 9, 1952, was forwarded to the heads of executive departments and agencies. It gave instructions for the control of dismissal during hazardous weather and added:

> "The attached policy for control of employee dismissals under hazardous traffic conditions in Washington was developed by the Federal Personnel Council in cooperation with the District of Columbia Government. The President asks that each department and agency follow it as general government policy.
>
> "This policy makes use of the irregular release hours already in effect so that a peak load will not be imposed upon transportation facilities before those facilities are prepared to accommodate the load. It also will permit more effective utilization of snow removal equipment."

Incidentally, this policy adopted under the Truman Administration was later reaffirmed by the Eisenhower Administration in a similar memorandum of March 14, 1953, to department heads.

### Campaign to Teach Winter Driving Techniques

To combat the unfamiliarity of many motorists with the art of winter driving, the committee recommended that the Department of Vehicles and Traffic through its Office of Traffic Safety Education and the Commissioners' Traffic Advisory Board, a citizen group,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NEW YORK
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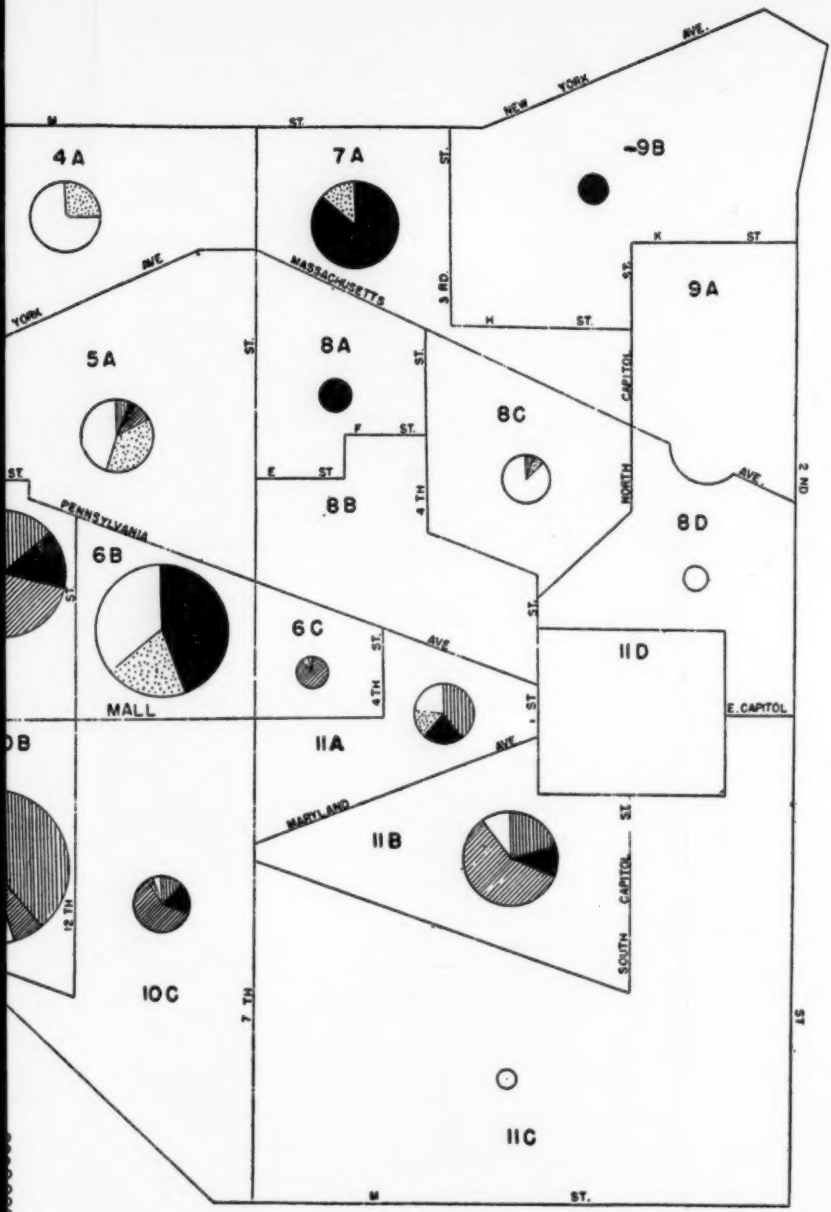



P.M. QUITTING TIME
OF FEDERAL EMPLOYEES
IN CONGESTED AREA
AS OF JUNE 30, 1950

DEPARTMENT OF VEHICLES & TRAFFIC
DISTRICT OF COLUMBIA

DRAWN BY JOHNSON
DATE 12-21-50
SHEET 2 / OF 2
DRAWING NO. 677

carry out a joint intensive educational campaign through press, television, radio, films, posters, leaflets, and other media to teach the driving public the art of snow driving. In addition to the regular press releases issued by the traffic department, the advisory board printed 100,000 fliers listing the streets from which improperly-equipped vehicles could be banned and giving basic rules for driving on snow and ice. Also thirty-five movie film trailers showing how to drive properly in winter were purchased and shown in theaters throughout the metropolitan area.

The traffic department's safety education office prepared a series of three announcements to be retained by newspapers and radio and television stations for release only upon authorization of the director of vehicles and traffic. Announcement No. 1 was the declaration of a snow emergency by the traffic director. Announcement No. 2 contained a firm forecast of snow, freezing rain or sleet, and a request by the director that government agencies dismiss their employees a specified number of hours ahead of their regular closing time. Announcement No. 3 was simply a forecast of bad weather but not a declaration of a state of emergency and not a request for early dismissal of government workers. Its purpose was to urge that trips by automobile be delayed until street conditions improved.

A plan for telephone communication of these announcements to police, mass transit, press, radio, television, government agencies, etc., was developed: Upon determination by the director of vehicles and traffic that a snow emergency situation exists, he notifies his deputy director, the Capital Transit Company, the police, the traffic safety officer, the Civil Service Commission, the public schools, and the Sergeants-at-Arms of the United States House and Senate. Each of these in turn has a list of persons or organizations to be notified. For example, the deputy director notifies the Public Utilities Commission and the automobile clubs; the traffic safety officer notifies press, radio and television, which have been extremely cooperative in getting this news to the public almost immediately. To relieve telephone pressure, it was also arranged that, by dialing Weather 3–1212, the public could learn whether the emergency had been declared.

As it happened, the snow regulations originally adopted were not

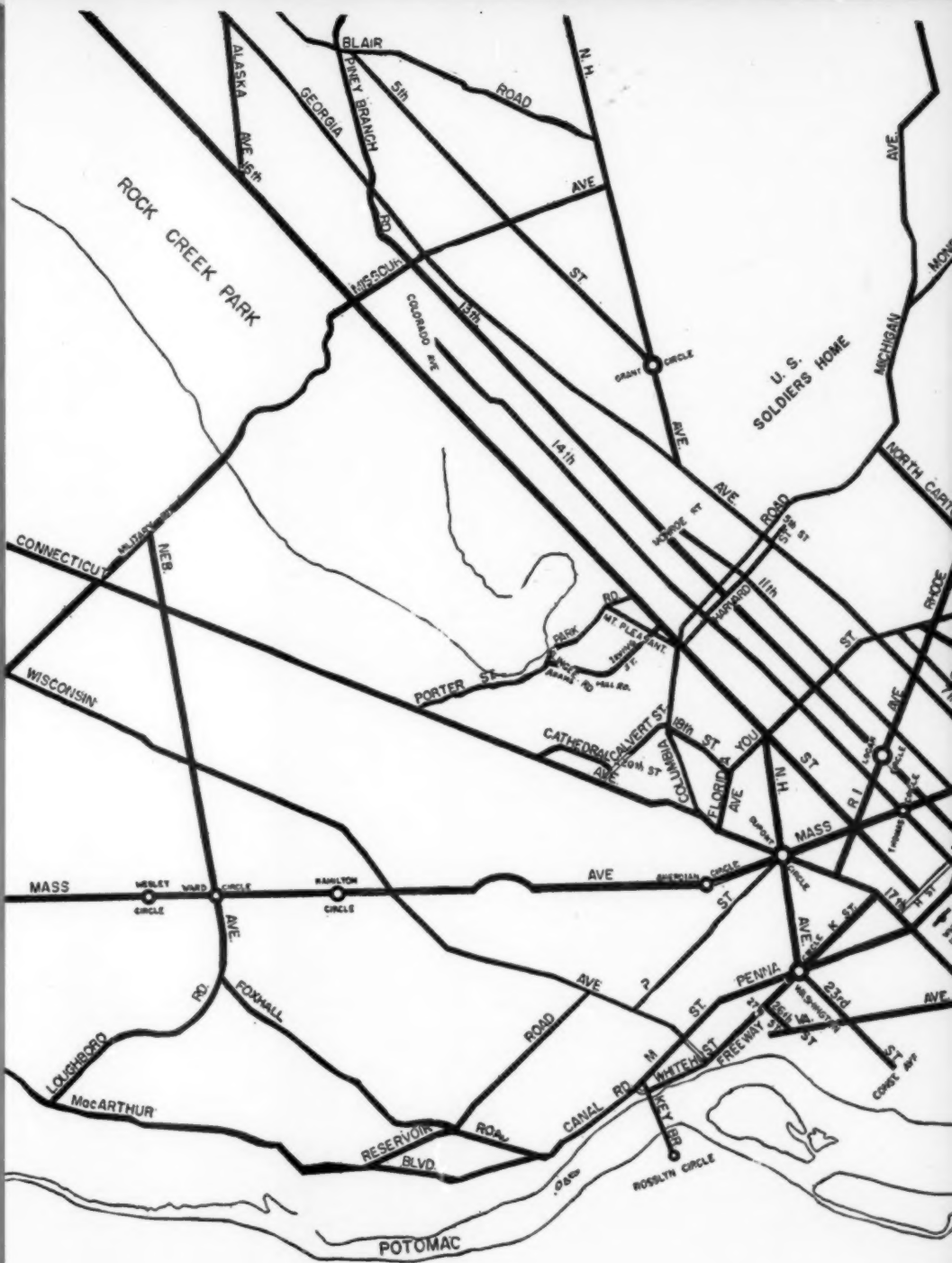
put to the test of an actual emergency situation during the first year. However, certain weak points in the program were immediately brought to light. In the first place, as originally worded, the regulation presented a difficult enforcement problem for the police. It would not be practicable for a police officer to stop and check every car to determine whether it carried chains or snow tires. Also, the police pointed out, it didn't make much sense to stop a vehicle which was moving along and not causing any trouble. Complaints from trucking concerns resented the fact that other truckers of certain categories were permitted to operate outside the regulation while they were expected to comply. The police found an additional enforcement problem in distinguishing among vehicles exempted and those not exempted.

### The Snow Emergency Plan Is Amended

The press was also rather critical of certain phases of the regulation. The Washington Post said "the requirement that vehicles be equipped with chains or snow tires before using 150 miles of city streets during snow conditions was a reflection of the frustration of the last fall . . . The regulation was studded with exceptions, making it difficult to enforce . . . Should the hapless, unchained motorist carry the list of verboten streets with him at all times, so that he will be able to route himself from one snow-clogged but approved sidestreet to another?"

The Washington Times-Herald asked, "With only one or two serious storms per year, how are motorists to learn the complicated net of highways which the commissioners have forbidden to ordinary traffic when streets are slippery or piled with snow? The chief flaw has always been the federal government which dismisses its employees willy-nilly during bad weather without advance notice to District or Capital Transit authorities . . ."

Other press comment agreed on the difficulty of identifying the special streets when an emergency arises. It was argued that motorists cannot be expected to remember which street is which, simply from seeing them on a map. The question was also asked if it were enough to designate some fifty-five streets for the use of vehicles equipped for snow-driving.




Washington's snow

now emergency streets.

Some papers offered more drastic suggestions:

1. Designate some streets as one-way; at least all traffic would be moving in the same direction.

2. Place boxes of salt in crucial points so that motorists themselves could put it on the street and the melting process could be started without waiting for the sanitation department.

3. Prohibit motorists from driving on streetcar tracks during storms, under penalty of fine, so that a few selfish drivers could not block thousands of transit riders.

4. Adopt the "Baltimore Plan," where police were authorized to bar all private automobiles from certain through-traffic streets used by buses and street cars.

The snow emergency committee took cognizance of all these suggestions and criticisms of the snow emergency plan. On August 14, 1952, one of the hottest days of the year, it met to consider further revision of the original regulation. Although the announcement of the snow emergency committee's meeting in the middle of the summer elicited amused comment from the press, it evidenced the fact that the committee was working the year round to make the snow emergency regulation effective. The headlines of the Washington News read "Without snow, it is just snow use."

To overcome a major criticism of the original plan, the committee proposed to the commissioners that the snow emergency streets be permanently marked by 20 inch-wide yellow bands painted on the first light pole at the entrance to each block on these streets. Approximately 4,400 such markings were required at the cost of approximately $1.00 per marking.

The committee also saw no point in exempting any vehicles from the plan. After all, it reasoned, if any emergency vehicle becomes stalled, it can no longer be classified as an emergency vehicle. It was agreed that no exemptions would be made. Most important, however, it agreed that no useful purpose was served by having a policeman stop a car which was not causing any trouble.

Therefore, to meet all these objections, the regulation was changed to read:

"Whenever snow, sleet or freezing rain is falling and the Director of Vehicles and Traffic finds that such snow, sleet or freezing rain is causing slippery or hazardous conditions which may lead to serious traffic congestion on

streets of the District, the Director of Vehicles and Traffic may declare an emergency, and until he has declared such emergency terminated, no vehicle shall operate on any of the following streets during such period of emergency in such manner as to become stalled and impede traffic when such stalling is due to the failure of such person to equip the vehicle with effective skid chains or effective snow-tread tires."

When the latest amendments to the snow regulations were announced, almost everyone agreed that the plan was as air-tight and as easily enforceable as reasonably possible. However, the division of sanitation still had cause for lament. No one had yet suggested what to do about parked vehicles which impeded the removal of snow from the streets during emergencies. The problem was tossed to the commissioners' traffic advisory board which came up with the following proposed regulation:

"During the period from November 15 to March 15 of each year, parking shall be limited to two hours on all arterial highways during the hours from 5 A.M. to 11 P.M. each day except Sunday. For the purpose of this regulation, arterial highways shall be construed to mean those highways upon which signs have been posted prohibiting parking between the hours of 7 to 9:30 A.M. or 4 to 6:30 P.M. on either side of such highways. Nothing in this regulation shall be construed as limiting the right to the commissioners to declare an emergency under any other regulation or order."

The board was of the opinion that a limited snow parking ban of this type would affect some areas where all-night or all-day parking is now occurring, but they attempted to leave available all-night parking up to 5 o'clock in the morning, at which time the two-hour limitation would take effect, thus requiring the removal of automobiles on arterial highways by 7 A.M.

### Restricted Parking on Major Arterials

At a later meeting on January 29, 1954, the commissioners' snow emergency committee considered this proposal, which was not entirely new.

In 1937 the board of commissioners had adopted a regulation prohibiting parking on major arterial streets between the hours of 2 and 7 A.M. for a three-month period between December 15 and

March 15 each year. The ban lasted until 1950 and permitted more efficient snow-plowing of arterial streets when it would least inconvenience the public.

However, every year there were complaints, chiefly from residents of the area affected. There is little doubt but that the ban inconvenienced the person used to parking his car in front of his residence all night. Conversely, it was impossible to plow a street through, with cars parked at the curb. A single car parked at the curb seriously interfered with the removal of snow in a block.

The ban posed several serious problems for the department of vehicles and traffic. To refurbish some 4,000 yellow and black snow parking signs each year, to erect them and take them down required some six weeks to two months' time of our sign crews. Furthermore, it was not always possible to place the temporary signs on the same post as the permanent parking signs. Some had to be erected on trees, other posts or light posts situated some distance away, thus causing some confusion and misunderstanding. All in all, the ban had proved generally unpopular.

It was therefore suggested that a ban against parking on any of the emergency streets between 12 midnight and 7 A.M. might be placed only while the snow emergency was actually in effect. This ban would not require any additional markings on the streets since the painted yellow bands are permanent. Furthermore, the yellow bands were considered legally sufficient for enforcement of the ban. It was conceded that, if the emergency were declared late in the evening, it would probably be impossible to secure compliance from motorists the same night, thus hampering snow-plowing the first night. However, this was felt to be the best compromise.

The proposed amendment was also so worded as to permit termination of the parking ban prior to the termination of the emergency, whenever the division of sanitation notified the director of traffic that parking on these streets would not interfere with snow-plowing or snow-removal operations.

Finally, the committee proposed the addition of certain streets to those on which the emergency regulation now applied; these included several truck routes, major arteries, bridges and approaches which had been omitted in the original regulation. This added some

thirty miles of streets in the District to the 112 miles already under snow emergency limitations. The proposed amendments were immediately adopted by the district commissioners.

### The Plan Is Put to The Test

The proof of the pudding is in the eating. Fortunately, fate intervened so that Washington did not have to eat its original snow-emergency pudding. No snow emergency was deemed necessary after the great storm of December 14, 1951, and all through the winter of 1952–53.

After the emergency plan had been whipped into more practical shape during the summer of 1953, the first test came at 7:45 P.M. on Friday, November 6, 1953. A declaration of snow emergency was made after police reported that conditions were not only bad but steadily getting worse. However, the emergency was short-lived and ended on Saturday morning at 10 A.M. The communication system worked well, with police, press, radio, and television getting the emergency declaration to the public in very short order.

At approximately 6 P.M. on Sunday, January 10, 1954, snow commenced to fall following a rainy day. By 9:30 P.M. conditions seemed sufficiently serious to justify declaring an emergency, which was done. Four inches of snow fell during that night and Monday morning before 7:25 A.M. when the snow stopped. Traffic moved well on January 11 and the emergency was terminated when conditions cleared up on Tuesday, January 12, at 2:45 P.M.

Incidentally, the first early dismissal, one and a half hours ahead of normal time, of government employees was requested at noon on January 11 on the basis of the slippery and hazardous conditions of the street at that hour and upon a weather bureau forecast of sleet.

The operation of the snow emergency plan on January 11 was generally termed a success. The following factors were seen as the most important in easing the effects of the storm. Only a fraction of the people who would normally drive took their cars out Monday. Many workers used public transportation. Many persons who would have come down to work or shop canceled their trips because of the emergency.

Tuesday (January 12) was one of the lightest automobile-traffic

days the city had seen in years. It saw the transit company getting 30,000 more passengers than it had a week before on the same day. The only explanation was that more motorists left their cars at home.

We had splendid newspaper, radio and television publicity which helped keep cars off the streets and caused more persons to equip their cars with chains and snow-tires.

In the first use of the emergency law, no persons were arrested, but numbers of stalled motorists were warned Friday night to equip themselves with chains. At noon on January 11, the second emergency, the Civil Defense air raid warning network of loudspeakers began broadcasting traffic instructions at my request. The broadcast asked listeners to move cars parked on the emergency streets in order to permit snow removal.

The early dismissal of government workers on a staggered schedule was a key factor in avoiding jams. The federal departments were most cooperative in the early release. The President Pro Tem of the Senate, Senator Knowland, announced in the Senate that we had requested the early release of federal employees "because of the weather and ice conditions, and the traffic congestion which is expected to develop . . . Pursuant to that request, I shall endeavor, within reasonable limitations, to conclude the session of the Senate shortly after three o'clock this afternoon, if it is possible to do so."

Although the storm didn't give the snow emergency regulation as severe a test as it might have received under the famous storm of December, 1951, the use of the regulation served two major purposes. It gave us a good chance to test our communication system. We were well satisfied with the way it worked. A second result of using the regulation was to help keep people aware of its existence and what it involved.

### Public Responds to Emergency Plan

The phone calls we received when the ban was first announced in 1952 repeatedly asked what the regulation was, what it meant, what streets were to be avoided, and so on. During our actual emergency experience in January, 1954, radio stations which broadcast announcements of the emergency and newspapers which publicized it remarked at the lack of confusion greeting the emergency. The few

phone calls it drew asked only whether the emergency was still in effect—not what it meant.

One of the best measures of the plan's success was the comment of some newspapers that perhaps the emergency had been lifted too soon on January 12. They noted that some area motorists, learning that they were no longer subject to fines if they stalled, got their automobiles out in force for the first time in three days. With traffic about 85 percent normal and streets still slick with ice and packed snow, a number of reports of traffic tie-ups were received for the first time since the storm.

The January 11 storm was by far the stiffest efficiency test of the regulation since its enactment. Not many arrests were made under it. In fact, few people were even ticketed. Yet traffic apparently moved smoothly under conditions which in previous years had meant chaos. A precinct-by-precinct police survey reflected this same report. After the snow came, the ban went into effect smoothly. Traffic dwindled to a minimum and that minimum moved right along.

Signs of approval came quickly. A Baltimore city council member urged a quick study of Washington's plan with a view to making it effective there. The newspapers reported that Professor Ralph A. Moyer, research engineer for the Institute of Traffic and Transportation of the University of California, had a chance to observe Washington in a snow storm and had nothing but praise for the way both District drivers and traffic officials coped with the emergency.

The Washington Star, in an editorial entitled "It Passed the Test" on January 16, said:

> "Washington's snow emergency plan passed its first big test with commendable success . . . The skeptics have been given an impressive demonstration of the worth-whileness of an emergency traffic-control plan with teeth in it. Repeated appeals for voluntary cooperation of drivers in avoiding practices that contribute to traffic snarls during snow storms had proved futile in years past . . . Apparently most cars not legally prepared to cope with emergency conditions were kept out of the restricted area . . . If motorists will continue to cooperate in making the new regulation work—a matter of self interest—the city need have no fear of a repetition of the paralyzing traffic jams that have developed in times past, even during light snow falls."

We had a third test last winter. At 5:40 A.M. Friday, January 22, 1954, Announcement No. 3 (Forecast of bad weather—no state of

emergency—no dismissal of government workers) was released. At 6:55 A.M. conditions had become so hazardous that the declaration of traffic emergency was put into effect. After consultation with the Commissioners, Announcement No. 2 (giving a firm forecast of bad weather and requesting the dismissal of government workers two hours ahead of schedule) was released. The state of emergency continued under control until 3 P.M. on Sunday, January 24, when it was terminated.

### Why It Worked

What is the magic ingredient of this regulation which so intangibly affects everyone who drives a private car over the snow on Washington's streets? After all, it is a simple prohibition, so simple that many of us wonder why Washington has been so long without it. Its efficiency apparently lies primarily in the very psychological effect it has on the motoring public. Those who equip their cars with snow-tires or chains do not stall on any of the principal streets. Those who aren't so equipped drive with added precaution over such streets, knowing it may cost them money and embarrassment if they do not. If it does nothing else, the emergency regulation keeps enough cars at home to enable us to handle those which do come out. Without necessity of stern enforcement, a substantial number of motorists voluntarily cooperate in keeping certain main arteries clear for mass transportation and emergency vehicles. And that, of course, is the major purpose of our snow emergency program.

# An Economical Modernization of the Sufficiency Study Procedure

MYRON D. BARTER AND JOHN K. MLADINOV

*Mr. Barter after considerable field engineering experience including service with the Army Engineers in the South Pacific, became associated with the Highway Planning Division of the Washington Department of Highways in 1946. He has worked primarily on planning and research studies and conceived and developed the methods described in the following article. He is now an assistant highway engineer.*

*Mr. Mladinov, senior planning engineer with the Washington Department of Highways, has been with the Department since 1947. He is a graduate of Columbia University and has a certificate from the Yale University Bureau of Highway Traffic. He is a registered civil engineer in the State of Washington and is an associate member of the Institute of Traffic Engineers.*

THE State of Washington Highway Sufficiency Rating Survey comprehensively evaluated every highway section in the state. The survey provides a measure of the adequacy of each roadway section to serve its volume of traffic structurally, safely, and with reasonable efficiency.

Each section is rated against the standards established for new construction for the class of highway involved. A rating of 100 indicates complete highway adequacy for the traffic demands and conformance to the respective construction standards. Ratings of less than 100 indicate simply the degree to which the roadway section fails to meet the constructional standards and the traffic demands being imposed upon it.

Sufficiency rating surveys are conducted primarily to guide the highway administrator in planning his construction and maintenance program. Over a period of years they will also indicate the effectiveness of statewide and district highway programs in coping with the deficiencies of the highway system. For instance, the overall average rating for the Federal Aid Primary highway system in Washington has shown an increase: 69 in 1950, 68 in 1951, 69 in 1952, and

71 in 1953. Undoubtedly this increase in recent years has resulted from the greatly accelerated highway program made possible by the total of almost $85,000,000 in highway bonds authorized for specific routes and projects by the 1951 and 1953 legislatures.

Another useful purpose of highway sufficiency rating surveys is to provide the general public and our legislative representatives with a readily understood, and yet scientifically established, measure of the overall highway problem and the picture of where any specific project stands in relation to the statewide and highway district priority list as determined by a rational and uniform rating system.

It must be emphasized that sufficiency rating surveys do not provide in themselves the actual priority listing for highway improvements. Through judicious use of sufficiency rating data, however, those responsible for the programming of highway projects are provided with a general guide in planning future highway activities. Other factors than sufficiency ratings must, of course, be considered in establishing actual work programs.

The first highway sufficiency study in the state of Washington was conducted in the summer and fall of 1949. The rating system was based on methods developed earlier by Karl Moskowitz for the state of Arizona. In 1950 and 1951, similar studies were conducted with only minor changes in the rating system. These field studies were made by a field crew of three men, usually composed of a department of highways engineer, a bureau of public roads highway engineer, and a department of highways maintenance engineer, the maintenance engineer being furnished by each highway district as it was surveyed. Besides the three field men, an office engineer subsequently had practically a full-time job in computing the average daily traffic volumes for the rated highway subsections and in calculating the sufficiency ratings from the field data collected and the traffic volumes.

## The Basic Rating

The so-called basic rating for each highway subsection was computed manually by summing the point values assigned to those individual physical and structural items considered in the rating system: subgrade, subbase, surface, drainage, surface width, shoulder widths, alignment characteristics, stopping sight distance, and passing sight

distance on two-lane roads or median width on four-lane roads. A rating adjustment was then introduced to compensate for traffic differences and relative traffic volume carrying capacities: the rating for road sections carrying a greater than average volume being penalized in rating while those with a less than average volume being credited with points.

The adjustment is made on the assumption that it is more important for a high volume section to conform to its design standards than for a low volume section. The traffic volume adjustment is based upon a set of empirical equations involving the logarithm of the traffic volume and was originally developed by Mr. Moskowitz. These equations were slightly modified for use in the state of Washington to better satisfy the different conditions experienced. These equations were converted into a family of curves for convenience, ease of use, and time saving, but at some sacrifice in preciseness of the results. Because of the many rated highway subsections, different traffic volumes, and different formulas for two- and four-lane highways, this was not only time-consuming; it was also one that offered chances for error, beyond the inherent lack of preciseness in the curves themselves.

After compilation into report form, the data were typed on multilith type paper plates, proofread, and reproduced. Any supplementary tabulations such as sufficiencies by highway district, highway route, region, county, traffic volume group, etc., had to be hand tabulated. In reviewing previous studies, it was found that the many special analyses being sought were nearly as time-consuming as preparing the original report itself. Because a reappraisal of the original 1949 "highway needs study" together with the preparation of a ten-year highway development program was scheduled for 1954, indications were that the 1953 sufficiency data were to be required in a shorter time than it had ever before been possible to prepare them by existing methods. Many special analyses of the data were to be required as well.

It was obvious, therefore, that an improvement in the methods of conducting and compiling sufficiency study data was highly desirable not only to speed up the work but also to increase the accuracy of the computations and to make the study more readily adaptable to the requirements of the numerous special analyses. Moreover the shortage of qualified engineering personnel made it mandatory that

the methods be such as to reduce the technical skills and time needed in all phases of the study from field work to completed report and special summaries.

## The Card Form

As a result of investigating various possibilities, business machine punch cards were chosen as the best carrier media of the information to be compiled. The reason for adopting this method was its flexible nature and the unlimited potentialities for reuse and retabulation of the information thus recorded, as well as permitting all necessary calculations to be made by automatic electronic machines.

After a thorough study of the possibilities, and the report and analysis requirements, a card form was set up and the 1952 data, already manually compiled and computed, was punched into cards and verified. In addition to data formerly included in the reports themselves, the cards were assigned an item number, one for each highway control section. The item numbers began with number 10, continuing in report sequence by tens until all the highway control sections were numbered. The gaps of ten in item numbers were left for any possible highway control sections that might be added in the future. Item numbers were necessary to permit the cards to be sorted back to their original book form sequence after any special analysis. The number of lanes was also added to the cards to permit the subsequent business machine automatic calculating of the adjusted rating.

To facilitate the recording of the field data during the 1953 field operations and its comparison with the previous year's ratings a field form was set up for the 1953 study. This form consisted of a reproduction from the cards of all of the 1952 report data except for the omission of all items that later would be accrued or calculated by machine. The omitted data consisted of *accrued miles, basic rating* and *adjusted rating*. On the other hand, the field form shows "item number," which does not appear in the published report. By showing the item number on the field form the engineer can, as required, add any new control sections or delete those that have been eliminated.

Because of the subsequent machine operations, it is no longer necessary for the field engineer to compute the subsection miles within each control section by manually totalling the individual sub-

section lengths. He merely posts the logged subsection miles and the machine subsequently adds them and prints the accrued miles and the total length for each control section. It is also no longer necessary to sum up manually the assigned rating values for each item inasmuch as the machine cross adds each value and posts the resulting basic rating for each subsection. The computing of the traffic volume adjustment and the resulting "adjusted rating" are also done automatically by machine. In the field the biggest advantage of such a field form is that the engineer always has the previous year's report before him. This permits easy and rapid comparison with the previous year's ratings. He also does not have to record any identifying data, or any ratings or data that have not changed since the previous report. Only the changes from the previous survey are entered. (See the attached sample form.)

After completing the field work, the field sheet becomes the code sheet from which the key punch operator punches the data onto cards. It is only necessary to punch the changes from the previous report inasmuch as the rest of the information can be reproduced directly from the previous year's cards.

Perhaps the biggest saving in time, labor, and costs and the greatest contribution to increased accuracy, however, come from the function performed by the business machine automatic calculator in computing the traffic adjustment and the resulting "adjusted rating." There are three different equations used in making this computation. They are as follows:

$$y = x + \frac{(x^2 - 100x)\ (\text{Log } t - \text{Log } Ts)}{100}$$ For all 2-lane primary highways ($Ts = 1560$)

$$y = x + \frac{(x^2 - 100x)\ (\text{Log } t - \text{Log } Ts)}{100}$$ For all 4-lane highways ($Ts = 11{,}300$)

$$y = x + \frac{(x^2 - 100x)\ (\text{Log } t - \text{Log } Ts)}{100}$$ For all 2-lane secondary highways ($Ts = 900$)

Where:

$x$ = Basic rating
$y$ = Adjusted rating (basic rating minus traffic adjustment)
$t$ = Average traffic volume for the highway subsection
$Ts$ = Overall average traffic volume for the highway system (and number of lanes) of which the subsection is a part.

**Further Card Systems**

Because of the increase in traffic volumes since 1949, when the original sufficiency survey was made, it was considered necessary to compute new Ts's (the overall average traffic volume) for each of the highway systems prior to performing the adjustment calculations. This is being performed by the business machine calculator also. The cards are sorted into three groups—2-lane primary, 4-lane, and 2-lane secondary highways. Total vehicle miles are automatically machine-computed for each group and divided by the total miles in each group, giving the overall average traffic volume.

This formerly was a long and tedious manual operation, subject to considerable human error, and therefore previously planned to be performed but once every few years, whereas it will now be done every year a survey is conducted because of the ease with which it is accomplished. At the same time the subsequent machine traffic adjustment calculations completely eliminate the necessity for the manual calculating and plotting of the families of adjustment curves and their recalculating and plotting each time the Ts's are changed as system-wide traffic volumes continue to increase.

The calculation of the traffic adjustment equation for each highway subsection was carried out by punching an additional set of tabulating cards with each card containing a traffic volume from 10 through 50,000 by tens, the logarithm for the respective volume, the logarithms for the three different Ts's, and the two divisors. The automatic business machine calculator matches (according to number of lanes and highway system in order to choose the proper formulas), a traffic volume in the detail cards punched from the field data and calculates and punches a plus or minus adjustment and the resulting "adjusted rating" into the proper space provided in the detail cards.

This whole operation is completed in a few hours, as compared to several weeks as formerly done by hand using the family of adjustment curves, and with complete accuracy and elimination of the possibility of human error.

Subsequent to the completion of all of the calculations the cards are machine-sorted according to the item numbers into the sequence desired for the final report. The tabulating machine then prints the

data onto reproducing type paper forms, making the necessary mileage accruals as it tabulates. The report is then printed on offset type printing machines directly, without the necessity for the transcribing of data, the typing, and the proofreading procedures previously required in preparing the report.

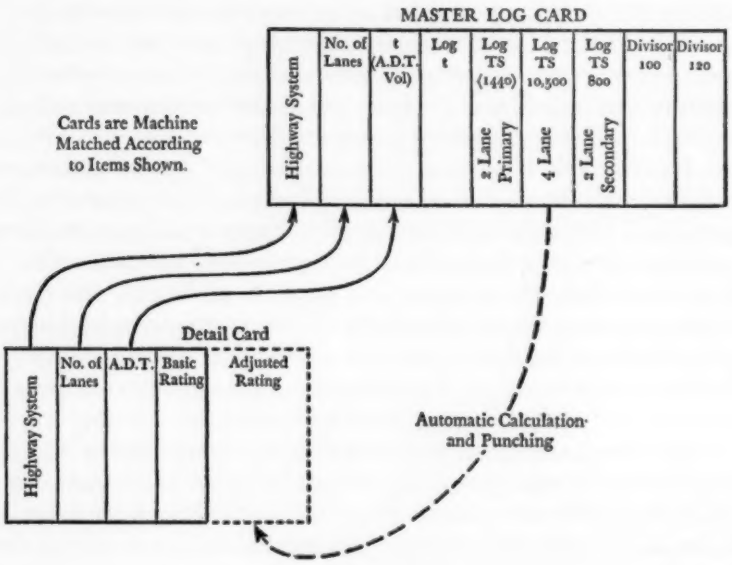



FIGURE 1

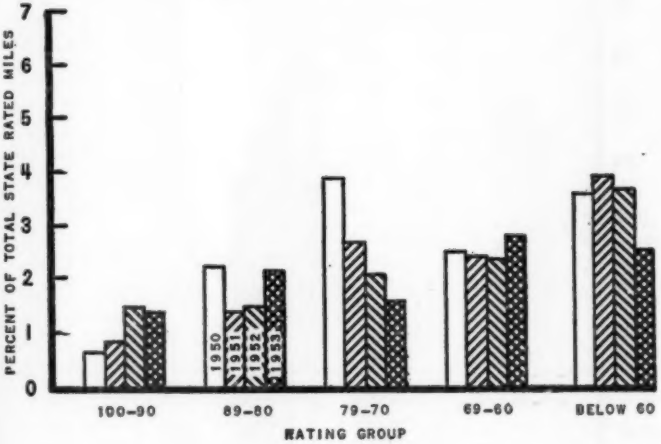
The field crew for the 1953 survey consisted of but two men, instead of three men, because of the simplification in field recording provided by the use of the field form. The complete rural highway system, both primary and secondary, was covered whereas in previous years it was possible to cover but one system each year.

Besides the considerable savings in field work and in compilation of the report itself, we are now in a position to supply any summary tabulations that might be required for any study with a minimum of time, effort, and cost. Some of the possible special summary tables which can easily be prepared are as follows:

1. Miles, vehicle miles, and ratings by Highway District.

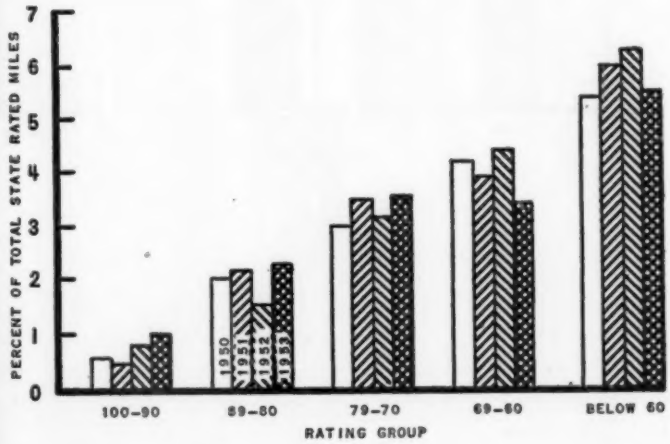
## HIGHWAY DISTRICT 1 (SEATTLE)

| YEAR | RATED MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 419 | 12.9 | 65 |
| 1951 | 343 | 11.1 | 65 |
| 1952 | 337 | 11.0 | 66 |
| 1953 | 306 | 10.5 | 69 |



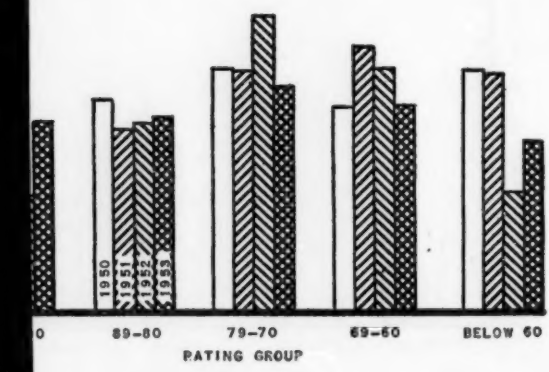

## HIGHWAY DISTRICT 4 (VANCOUVER)

| YEAR | RATED MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 490 | 15.1 | 63 |
| 1951 | 495 | 15.9 | 62 |
| 1952 | 498 | 16.3 | 62 |
| 1953 | 440 | 15.1 | 67 |



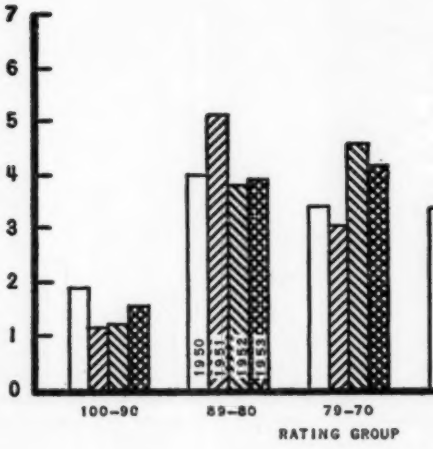
## HIGHWAY DISTRICT 2 (WENATCHEE)

| YEAR | RATED MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 583 | 17.9 | 69 |
| 1951 | 566 | 18.3 | 69 |
| 1952 | 548 | 17.9 | 73 |
| 1953 | 536 | 18.4 | 75 |



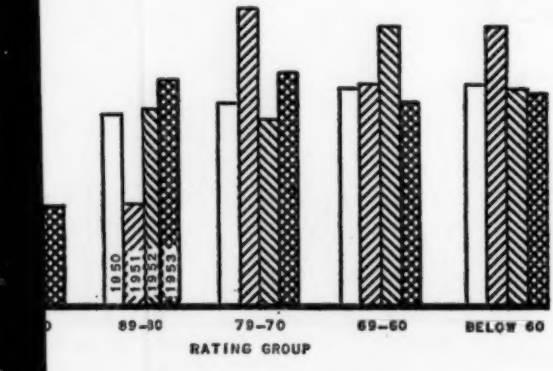

## HIGHWAY DISTRICT 3 (OLYM

| YEAR | RATED MILES | % OF STATE TOTAL | W AVER |
|---|---|---|---|
| 1950 | 576 | 17.7 | |
| 1951 | 573 | 18.4 | |
| 1952 | 571 | 18.6 | |
| 1953 | 550 | 18.9 | |



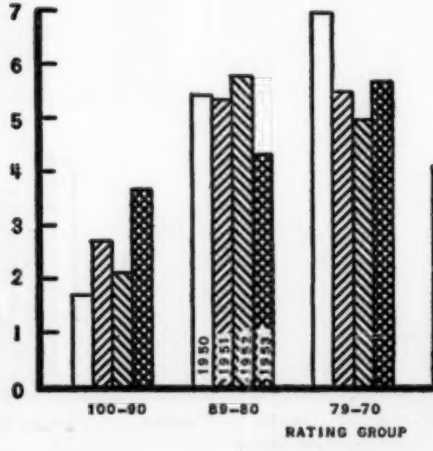

## HIGHWAY DISTRICT 5 (YAKIMA)

| YEAR | RATED MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 523 | 16.1 | 69 |
| 1951 | 533 | 17.2 | 67 |
| 1952 | 524 | 17.1 | 69 |
| 1953 | 522 | 18.0 | 71 |



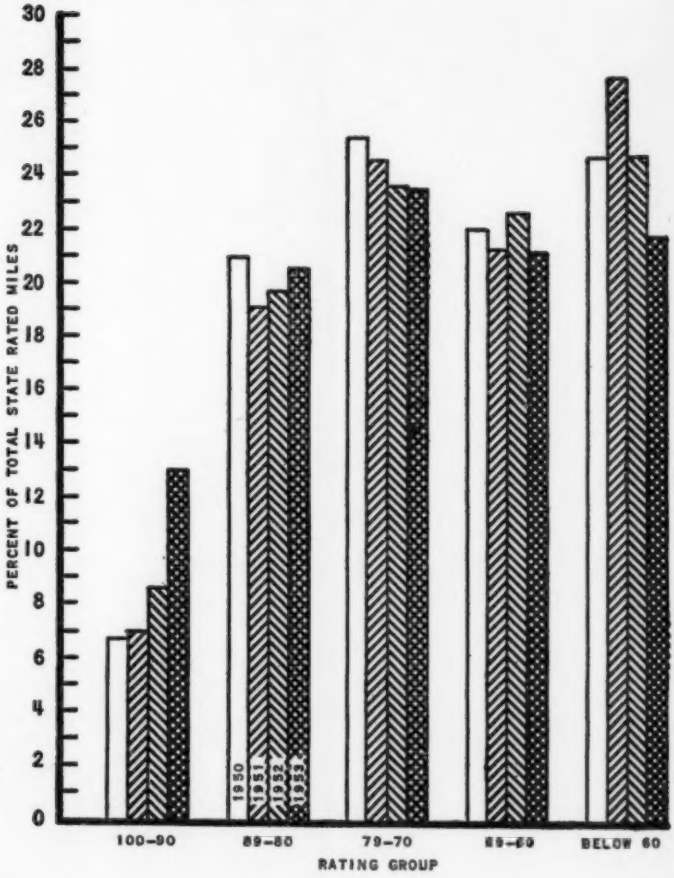

## HIGHWAY DISTRICT 6 (SPO

| YEAR | RATED MILES | % OF STATE TOTAL | AVE |
|---|---|---|---|
| 1950 | 662 | 20.3 | |
| 1951 | 592 | 19.1 | |
| 1952 | 584 | 19.1 | |
| 1953 | 553 | 19.1 | |



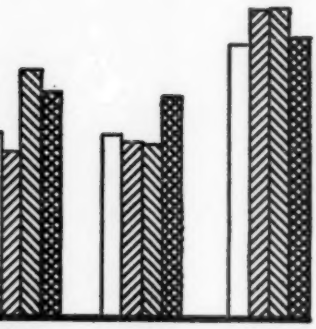
## STATE-WIDE TOTAL

| YEAR | RATED MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 3253 | 100.0 | 69 |
| 1951 | 3102 | 100.0 | 68 |
| 1952 | 3062 | 100.0 | 69 |
| 1953 | 2907 | 100.0 | 71 |



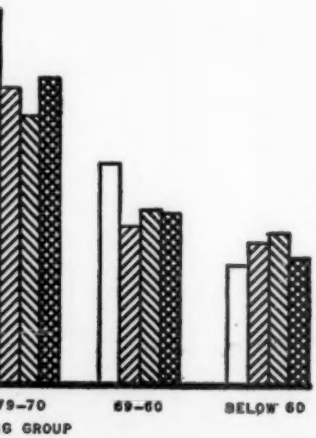

## ICT 3 (OLYMPIA)

| F TOTAL | WEIGHTED AVERAGE RATING |
|---|---|
| 7 | 69 |
| 4 | 69 |
| 6 | 68 |
| 9 | 69 |



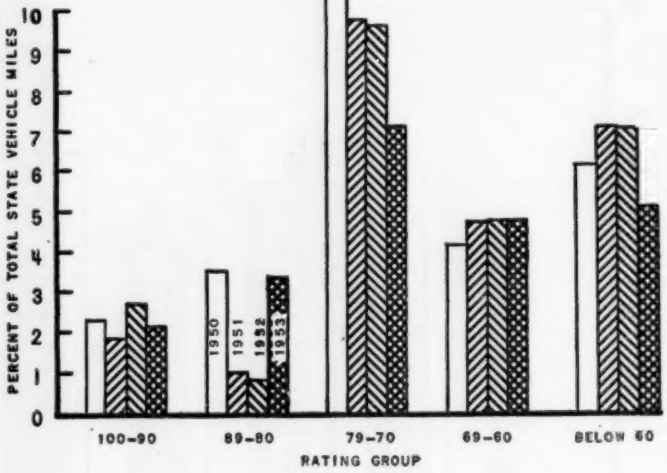

## ICT 6 (SPOKANE)

| F TOTAL | WEIGHTED AVERAGE RATING |
|---|---|
| 3 | 74 |
| 1 | 75 |
| 1 | 72 |
| 1 | 75 |



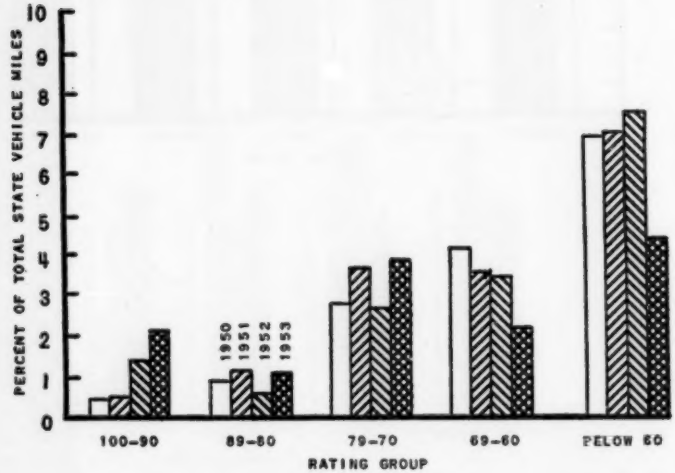
## HIGHWAY DISTRICT 1 (SEATTLE)

| YEAR | DAILY VEHICLE MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 1,868,500 | 27.3 | 68 |
| 1951 | 1,845,300 | 25.4 | 66 |
| 1952 | 1,840,300 | 26.0 | 66 |
| 1953 | 1,613,500 | 23.9 | 69 |




## HIGHWAY DISTRICT 4 (VANCOUVER)

| YEAR | DAILY VEHICLE MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 1,022,100 | 14.9 | 63 |
| 1951 | 1,127,400 | 15.5 | 62 |
| 1952 | 1,109,200 | 15.7 | 62 |
| 1953 | 929,100 | 13.7 | 67 |



HIGH

| R | DAI VEHICLE |
|---|---|
| 0 | 630. |
| 1 | 692. |
| 2 | 619. |
| 3 | 676. |

00 89-

HIG

| AR | DAI VEHICLE |
|---|---|
| 50 | 1.154 |
| 51 | 1.209 |
| 52 | 1.082 |
| 53 | 1.194 |

90 89-

HIGHWA

DAIL
VEHICLE M

630,5
692,1
619,9
676,9

1950
1951

89-

HIGH

DAI
VEHICLE

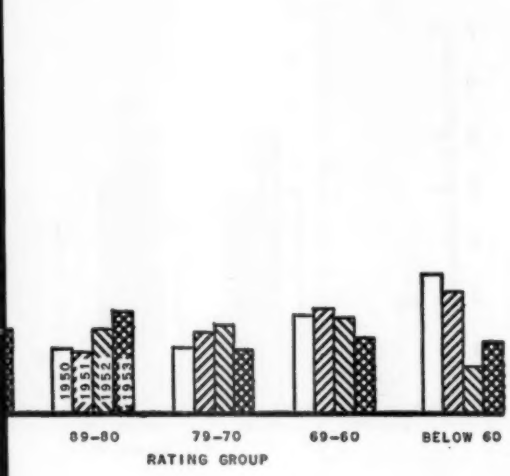
1,154
1,209
1,082
1,194

1950

89-

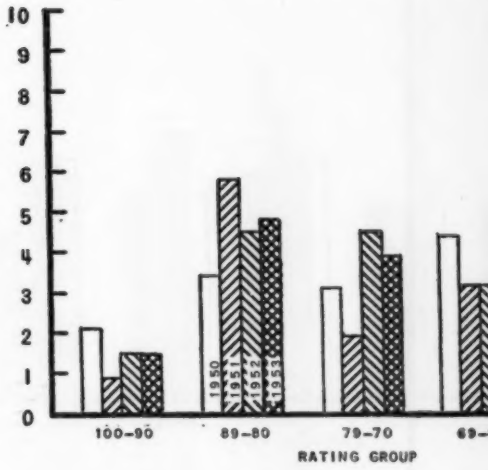
## HIGHWAY DISTRICT 2 (WENATCHEE)

| DAILY VEHICLE MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|
| 630,500 | 9.2 | 65 |
| 692,100 | 9.5 | 66 |
| 619,900 | 8.7 | 73 |
| 676,900 | 10.0 | 76 |



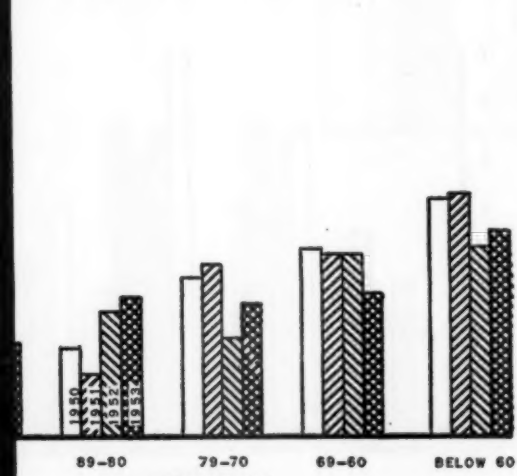

## HIGHWAY DISTRICT 3 (OLYMPIA)

| YEAR | DAILY VEHICLE MILES | % OF STATE TOTAL | AVER |
|---|---|---|---|
| 1950 | 1,256,300 | 16.3 | |
| 1951 | 1,296,400 | 17.8 | |
| 1952 | 1,395,100 | 19.7 | |
| 1953 | 1,336,800 | 19.8 | |



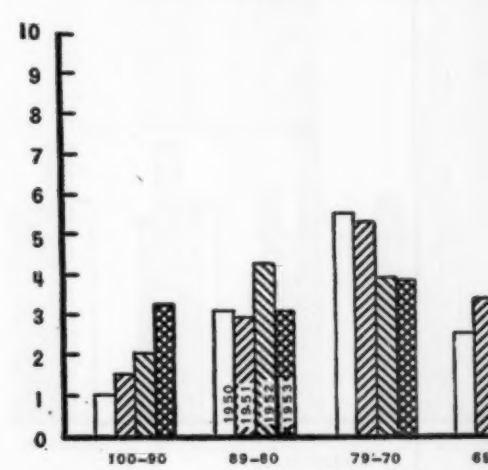

## HIGHWAY DISTRICT 5 (YAKIMA)

| DAILY VEHICLE MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|
| 1,154,800 | 16.9 | 69 |
| 1,209,000 | 16.7 | 67 |
| 1,082,600 | 15.3 | 69 |
| 1,194,400 | 17.7 | 71 |



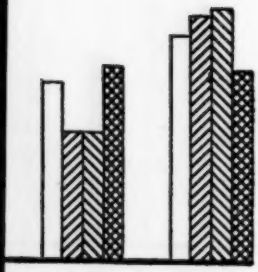

## HIGHWAY DISTRICT 6 (SPOKANE

| YEAR | DAILY VEHICLE MILES | % OF STATE TOTAL | AVE |
|---|---|---|---|
| 1950 | 919,100 | 13.4 | |
| 1951 | 1,098,800 | 15.1 | |
| 1952 | 1,034,700 | 14.6 | |
| 1953 | 1,009,000 | 14.9 | |



(OLYMPIA)

| TAL | WEIGHTED AVERAGE RATING |
|---|---|
| | 67 |
| | 68 |
| | 68 |
| | 69 |




P

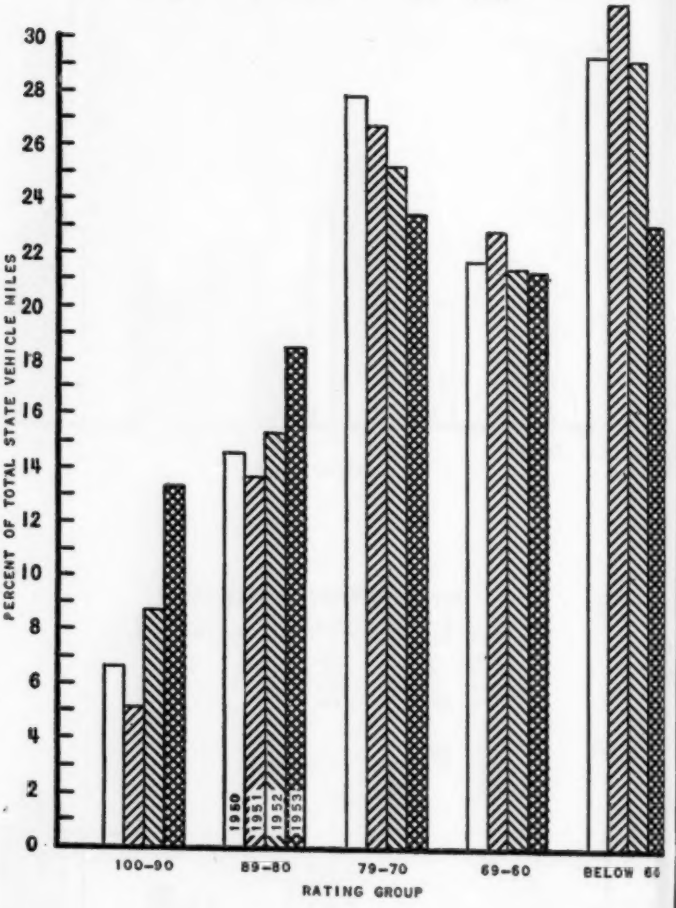
(SPOKANE)

| OTAL | WEIGHTED AVERAGE RATING |
|---|---|
| | 74 |
| | 75 |
| | 72 |
| | 75 |

UP

STATE-WIDE TOTAL

| YEAR | DAILY VEHICLE MILES | % OF STATE TOTAL | WEIGHTED AVERAGE RATING |
|---|---|---|---|
| 1950 | 6,851,300 | 100.0 | 69 |
| 1951 | 7,269,000 | 100.0 | 68 |
| 1952 | 7,081,800 | 100.0 | 69 |
| 1953 | 6,759,700 | 100.0 | 71 |



2. Miles, vehicle miles, and ratings by County.

3. Miles, vehicle miles, and ratings by highway number or Federal Aid route number.

4. Miles, vehicle miles, and ratings by Federal aid highway system.

5. Miles, vehicle miles, and ratings by terrain (mountainous, level or rolling).

6. Miles, vehicle miles, and ratings by surface type.

7. Miles, vehicle miles, and ratings by number of lanes.

8. Vehicle miles by highway control section.

9. Location of structural adequacy and safety-service deficiencies.

10. Miles of road with various average traffic volumes.

The accompanying illustrations are an example of data obtained from sufficiency survey information with a minimum of effort once the conversion is made to punch card techniques. The previous few years' surveys were placed on cards in order to permit comparative studies to be made easily. The first diagram shows a four-year comparison of the mileage of Federal Aid Primary highways which falls within each of the sufficiency rating groups for each of the state highway districts and for the state as a whole. Because of variations from year to year in the total rated mileage as a result of construction projects, additions, and/or deletions from the system the mileage is shown on a percentage basis.

Inasmuch as it is conceivable that the year-to-year comparisons on a mileage basis may show improvement, while on a basis of service to the most motorists (as revealed by a vehicle mile comparison) there may not be a corresponding improvement shown, a similar comparison was made for the Federal Aid Primary highways on the latter basis. This illustration reveals that a somewhat greater percentage of the state's vehicle miles of travel falls into the lower sufficiency rating groups than does the percentage of the actual mileage, while a correspondingly smaller percentage of vehicle miles is in the higher sufficiency rating groups. However, the general trend from year to year appears to be quite similar for both the mileage and the vehicle mileage comparisons:

FEDERAL AID PRIMARY HIGHWAY SYSTEM OVERALL STATEWIDE AVERAGE SUFFICIENCY RATING

| *Year* | *Mileage Basis* | *Vehicle Mile Basis* |
|---|---|---|
| 1950 | 69 | 67 |
| 1951 | 68 | 66 |
| 1952 | 69 | 67 |
| 1953 | 71 | 71 |

## Conclusion

A method of advantageously utilizing business machines in the conduct of all phases of the annual sufficiency studies has been developed.

By the use of a business machine prepared listing as a field form it has not only been possible to eliminate one man from the field crew but the remaining men can conduct the study faster because of the elimination of the recording of descriptive information and other data that remain unchanged from the previous year's survey. With the previous report's data printed on the field form the field work is simplified and more easily correlated from year to year.

The field form is the code sheet from which business machine punch cards are prepared directly. It is only necessary to punch cards for those subsections where items of information have changed, with these new cards replacing the old cards in the overall set from which the report is printed.

The business machines automatically make all of the necessary calculations and completely eliminate all chances of human error as well as the inherent error in the use of the family of curves necessary in the previous calculating method. The business machines have not only reduced the time to make these calculations to less than one-tenth that previously required but at the same time have released critically needed technical personnel for other duties.

The report is printed directly from the special reproducing plates prepared by the business machine. All typing and proofreading time has been eliminated.

The final results of the sufficiency study and the published report

can now be completed in a matter of a few weeks from the time of completion of the field work rather than the months formerly required when the data were processed by hand. It is now possible to cover both the primary and secondary highway systems each year, if need be, instead of in alternate years.

Because all of the data is on business machine punch cards special analyses and tabulations can be prepared with an absolute minimum of effort and time, especially of technical personnel.

The overall costs of the sufficiency study are estimated to have been reduced by approximately one-half.

### Sample Field Form

Figure 4 shows a field form for the 1953 Sufficiency Survey together with a corresponding sheet from the completed report of which this field sheet became a part. It is a listing printed by a business machine of the 1952 Sufficiency Survey detail cards with the machine set to triple space, allowing room for the 1953 field notes to be entered between the printed lines as the survey is made. A short explanation of each field entry follows:

The first group of subsections is a part of highway control section 3933. The only change in the first line, subsection 02, was the A.D.T., (average daily traffic volume). Subsection 03 remained the same (being the City of Mabton), while subsection 04 experienced a traffic volume change only. Subsection 05, which was obviously a poor section rating only 46 of the possible 100 basic points in 1952, was being reconstructed at the time of the 1953 Sufficiency Survey.

Control Section 0334, with the exception of the urban portion (the City of Prosser), was under construction in 1953, its two subsections having rated only 39 and 32, respectively, out of 100 basic points the previous year.

Control Section 3930 has 5 subsections that in all cases had traffic volume changes. In addition, subsections 01 and 04 had the surface rating reduced also. The traffic change (to 4000 or over) in subsection 05 resulted in changing the design classification to which the section was to conform. The changed standards are shown together with the resulting reduction in surface and shoulder-width ratings.

The last two lines are a portion of Control Section 3931 and here again the traffic had increased over the previous year.

Inasmuch as the business machine cross-adds the new totals and posts the resulting basic rating, totals and posts the rated miles,

| Highway Number: State | Fed. Aid No. | Location or Remarks | Sub-section Miles | District | No. of Lanes | Surface Type | Control Section | Sub Section | Standards | | | | Sufficiency Ratings: Str. Adequacy | | | | | Safety - Service | | | | | | A.D.T. | Item |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | 8 | 7 | 15 | 10 | Total 40 | 15 | 10 | 17 | 10 | 8 | Total 60 | | |
| 3A | 268 | | 1392 | 5 | 2 | F | 3933 | 02 | 1 | 70 | 22 | 08 | 6 | 6 | 07 | 07 | 26 | 12 | 00 | 17 | 08 | 7 | 44 | ~~[illegible]~~ 1720 | 2520 |
| 3A | 268 | MABTON | 0053 | 5 | | U | 3933 | 03 | | | | | | | | | | | | | | | | | 2520 |
| 3A | 268 | | 0507 | 5 | 2 | F | 3933 | 04 | 1 | 70 | 22 | 08 | 6 | 6 | 06 | 07 | 25 | 12 | 00 | 17 | 06 | 6 | 41 | ~~1500~~ 1580 | 2520 |
| 3A | 268 | Under Construction | 0103 | 5 | ~~2~~ | ~~F~~ W | 3933 | 05 | ~~[illegible]~~ | | | | ~~[illegible]~~ | | | | | | | | | | | ~~[illegible]~~ | 2520 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3A | 268 | BENTON CO TO JCT PSH 3 | 0478 | 5 | ~~2~~ | ~~F~~ W | 0334 | 01 | ~~[illegible]~~ | | | | ~~[illegible]~~ | | | | | | | | | | | ~~[illegible]~~ | 2530 |
| 3A | 268 | PROSSER | 0042 | 5 | | U | 0334 | 02 | | | | | | | | | | | | | | | | | 2530 |
| 3A | 268 | Under Construction | 0147 | 5 | ~~2~~ | ~~F~~ W | 0334 | 03 | ~~[illegible]~~ | | | | ~~[illegible]~~ | | | | | | | | | | | ~~[illegible]~~ | 2530 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3B | 269 | WHITE SWAN TO JCT PSH 8 | 0611 | 5 | 2 | F | 3930 | 01 | 1 | 60 | 22 | 08 | 6 | 6 | 04 | ~~07~~ 06 | 23 | 07 | 00 | 14 | 07 | 4 | 32 | ~~520~~ 580 | 2540 |
| 3B | 269 | | 0673 | 5 | 2 | G | 3930 | 02 | 1 | 60 | 22 | 08 | 6 | 7 | 12 | 09 | 34 | 15 | 10 | 17 | 10 | 8 | 60 | ~~[illegible]~~ 750 | 2540 |
| 3B | 269 | | 0151 | 5 | 2 | G | 3930 | 03 | 1 | 70 | 22 | 08 | 6 | 7 | 12 | 09 | 34 | 11 | 08 | 17 | 10 | 8 | 54 | ~~1700~~ 1750 | 2540 |
| 3B | 269 | | 0576 | 5 | 2 | J | 3930 | 04 | 1 | 70 | 22 | 08 | 6 | 6 | 02 | ~~[illegible]~~ 11 | 26 | 07 | 02 | 17 | 10 | 8 | 44 | ~~1700~~ 1750 | 2540 |
| 3B | 269 | | 0044 | 5 | 2 | I | 3930 | 05 | 1 | 70 | ~~22~~ 18 | ~~08~~ 10 | 6 | 6 | 12 | 10 | 34 | ~~07~~ 00 | ~~08~~ 00 | 17 | 10 | 8 | 44 | ~~3000~~ 4000 | 2540 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3C | 270 | JCT SSH 3B TO JCT SSH 3A | 0503 | 5 | 2 | G | 3931 | 01 | 1 | 70 | 22 | 08 | 6 | 6 | 10 | 09 | 31 | 11 | 08 | 15 | 10 | 7 | 51 | ~~[illegible]~~ 950 | 2550 |
| 3C | 270 | | 0479 | 5 | 2 | F | 3931 | 02 | 1 | 70 | 24 | 10 | 6 | 6 | 10 | 09 | 31 | 07 | 06 | 15 | 10 | 8 | 46 | ~~[illegible]~~ 1900 | 2550 |

FIGURE 4

and computes and posts the adjusted rating in the finished report, entries have not been made on the work form for these items which the machine will subsequently complete.

When the survey field work is complete these field forms are given to the key punch operator who punches the new cards directly with no need for transcribing, checking, or coding of information.

# Grand Rapids, Michigan: Its Everyday Traffic Engineering

JEROME D. FRANKLIN

*Mr. Franklin has been for five years city traffic engineer of Grand Rapids, Michigan. Previously he was associate traffic engineer, New Jersey Division of Motor Vehicles, for two years. He holds a certificate from the Yale Bureau of Highway Traffic and is a registered professional engineer. Mr. Franklin is a member of the Institute of Traffic Engineers, and of the Highway Research Board Committee on Parking, Washington, D.C.*

IN Grand Rapids, through public relations, selling, and human understanding, a successful program of traffic engineering was introduced into what was an already successful traffic and safety program. The city's traffic engineering is based upon the principles of technical standards applied throughout the profession. To be applied successfully for the first time, five years ago in this community, it was necessary to add "human engineering" combined with practical politics.

Fundamentally, our division is based not only on the three E's but on the three C's—Courtesy, Coordination, and Cooperation. And it uses the all-important catalytic agent of *service*.

In organizational set-up, our division is in an almost ideal operating position. We are responsible for the planning and adoption of all traffic control policies (other than enforcement); for the operation and administration of the municipal parking ramp, and several municipally-owned off-street parking lots; and for determining and installing traffic signals, signs, markings, and parking meters.

Grand Rapids' government is based upon the commission-manager form. The mayor is elected on a citywide basis; and two commissioners from each of the three wards. They are elected for two-year terms and since the terms are echeloned, there is an election every year. That means our city is never more than six months away from an election. In the last few years, these elections have played a most important role concerning municipal policy inasmuch as the majorities have never exceeded 4 to 3.

The traffic engineering division has tried to sell itself to the various city commissioners and city managers by explaining that rather than make a political issue of traffic, like the sewage and water problems, traffic should be treated factually, with the division head assuming the responsibility and the blame for any changes. One advantage of this operation is that, unlike many other communities, traffic control installations and all other changes are instituted by this division directly without the compulsory approval of the city commission.

In fact, since our division is solely responsible to the city manager, he in theory makes the rules. With regard to changes such as the major street plan, expressway routing, etc. we have discussions and hearings. This policy also applies to signs and other devices which, according to our interpretation of the traffic ordinance and city charter, become official as soon as they are placed on the street. This freedom of action also applies to the installation and removal of parking meters, bus stops, taxi stands, loading zones, etc.

The traffic commission, prior to the inauguration of the traffic engineering division, was the quasi-traffic engineering body. Since the creation of our division, the traffic commission concerns itself with problems so controversial that they are of wide public concern. Yet only secondarily do they involve traffic engineering. The traffic commission, composed by ordinance of four resident citizens and four city officials (city manager, superintendent of police, a city commissioner and the traffic engineer), helps act as a buffer and time-saver for the city commission which does not have to spend much time on each question.

The concentration of all traffic control within the traffic engineering division makes it easier to transfer men, material, and budgetary items between the various sections when necessary. On the whole, because of the manager-type of government, this feeling permeates the entire city force, and since our division is on the same level as other operating divisions, there has not been a single division we have not worked with.

For instance, inasmuch as our sign shop is equipped for this type of work, we have actually solicited the various city divisions to use the services of our sign painter, to keep the shop at full production. Naturally, we are able to make these signs less expensively than if

purchased from outside vendors. We have made signs for the library, park, and retail market.

In more detail, other city divisions with which we primarily work are:

1. *Police Division*

This department is always consulted on basic future policies so we can coordinate enforcement. In many instances, signs dealing with limited parking could not be enforced because of insufficient personnel, and even though the request is warranted, we do not proceed with the installation. Other items we deal with are enforcement policies, parade routing, ordinance revisions, etc.

2. *Engineering and Maintenance Divisions*

These divisions confer with ours since we approve all requests for large driveway openings before a permit can be issued by the city engineer. In addition, we are consulted concerning house movings, vacations of streets, temporary street closings, detours, and excavations. We have used the facilities of this division for survey work and for detailed construction.

3. *Planning Division*

Our division deals with both the planning commission and the city planning division itself. We consult this division concerning the larger aspects of the major street planning, and the proposed Grand Rapids Expressway. In addition, we are in daily contact because our zoning ordinance requires that each permit for construciton (outside the central business district) be approved for off-street parking. To facilitate the parking and to provide service to the public, representatives from our division and the planning division inspect all building applications on the scene together and thus can jointly either approve or disapprove the application.

The ordinance is strict concerning off-street parking and since its adoption two years ago, thousands of off-street parking spaces have come into existence. Another advantage of this ordinance is that it provides contact with numerous architects, engineers, and builders who, knowing the ordinance standards, have over a period of time begun to realize its strictness. Accordingly, they now prepare

plans which in many cases are readily acceptable when initially submitted.

4. *Board of Zoning Appeals*

This separate body, not responsible to the city commission, investigates applications for variations from the zoning ordinance, and regardless of the variation granted, consults our division since it rightfully insists on the maximum amount of off-street parking. This again is accomplished because of the good working relations of our division in giving prompt service to the building inspector who is the coordinator for the zoning board.

5. *Fire Division*

The fire division is consulted about all traffic changes directly involving any particular fire station or fire route. All major one-way street proposals are discussed with the fire chief and, in addition, all requests from the various district chiefs for elimination of parking because of narrow streets. In the event of large fires, our department provides the necessary detour signs and barricades to provide as large and clear working area as possible. When streets are barricaded for excavations, or closed for any other reason, the fire dispatcher is notified.

6. *City Treasurer*

This office counts and deposits all parking meter and the municipal parking ramp revenues which are collected daily.

7. *Comptroller and Auditor*

This division is responsible for overseeing our budget.

8. *Purchasing Division*

The purchasing agent is responsible for buying our supplies and for coordinating the activities carried on with other divisions in the city concerning manpower. These include the arranging of crews from the city maintenance division for actual installation of meters in new districts, black-topping of city-owned off-street parking facilities, removal of snow from the city parking ramp, etc.

9. *Park Division*

The park division consults our division concerning off-street parking facilities in the parks, traffic directional flows, and, in turn, we request their help in trimming trees and bushes which interfere with traffic signals, or limit sight distance at potentially hazardous intersections.

10. *Water Works and Street Lighting Division*

We consult with this division concerning new street lighting installations and improvements. Also, since our sign shop is in one of the water works buildings, we are dependent on them for other services, such as the use of the machine shop.

11. *City Clerk's Office*

The city clerk not only provides this department with the minutes of the city commission (all meetings of which are attended by the traffic engineer) but also assists in the preparation of ordinances. The police patrolmen assigned to the city clerk's office for permit inspection notify us in many instances of violations that this division can remedy.

12. *City Attorney*

The city attorney not only represents our division in all legal matters, but assists in preparing our ordinances.

13. *Civic Auditorium*

The Grand Rapids Civic Auditorium, which annually plays host to more than 150 conventions, consults our division with regard to special parking permits for buses and mobile display units in conjunction with the conventions. Our policy is never to provide special parking permits for private cars; in fact, no special parking privileges for physicians, church patrons, residents, etc. are permitted. This is contrary to good practice, in our opinion.

14. *Parking Authority*

Another official body our office deals with is the Grand Rapids Parking Authority consisting of seven citizens, the mayor and the

city manager. The parking authority serves as an advisory body in that important decisions of proceeding with projects and surveys depend upon the formal approval of the city commission.

Since its inception, the parking authority has acquired three parcels of land, two in the central business district and one in the largest outlying business area. In the central business district, across from the city hall, a 311-stall ramp featuring self-parking was built in 1950–51, while at the other location, a 125-car lot has been leased to a private operator. The outlying lot has a capacity of 180 metered stalls. Although the traffic engineer is not officially a member of the parking authority, he serves as advisor and secretary, and is also responsible for the operation of the parking authority's facilities.

Again, from the point of service and public relations, the parking authority has granted the privilege of free parking to members of boards and to city commissioners, while they are on official city business. This minor courtesy has helped the governing body attract many fine citizens to serve, because they can no longer use the excuse that it was impossible to park near the city hall. Because of the revenue bond requirements, the city must reimburse the parking system and, accordingly, a monthly tally is made of the courtesy parkers, at which time a bill is presented.

## Non-local Government Agencies

1. *County*

Since there are no county-maintained roads within the city limits, we have few intra-relations other than the maintenance and operation of traffic signals, for which by agreement we are responsible. Several streets situated half in the city, half in the county, are by agreement maintained by the county. In these instances, we do not confer for coordinating proper traffic control measures.

2. *Michigan State Highway Department*

All traffic signals must be approved by the Michigan State Highway Department. Consequently close contact is made with the district highway traffic engineer. Conferences also deal with other major problems of the state highway system—channelization, parking restrictions, etc.

## Quasi-Public Agencies

1. *Grand Rapids Safety Council*

Grand Rapids has one of the first local safety councils in the country. Through the interest of the safety council, which makes the purchases, we place accident-prevention signs of the small billboard type in about forty locations on major roadways within the city. These signs, similar to those erected all over Michigan, are changed monthly. In addition, the safety council has formed a railroad crossing improvement committee that inspects city and county crossings, and submits its recommendations.

2. *Chamber of Commerce*

The Grand Rapids Chamber of Commerce, through its various committees, has helped coordinate policies of traffic and expressway planning and at the present time is sponsoring a downtown parking survey in cooperation with the traffic engineering department.

3. *Utility Companies*

We are in contact with the utility companies at all times to advise them about scheduling and construction limitations of street openings for maintenance repairs which are particularly prevalent during the summer months. We also recently sought their advice on a municipal accident-prevention program we are undertaking.

4. *Bus and Taxi Companies*

One of our prime functions dealing with these agencies is the determination of routes and stops. Because of the liberal working practices much has been done with regard to re-location of routes, particularly on one-way streets, and the consolidation of stops so as to avoid undue congestion, and at the same time insure proper bus-stop lengths. This not only applies to the local motor coach company, with which we maintain excellent working conditions, but also to the several interurban and inter-city carriers. Through the "practical politics" of informal courtesies and contacts with these organizations, many of our improvements have been accomplished.

## Private Organizations

1. *Newspapers, Radio and T.V.*

Because of the political situation in our community, which is best described by saying that it is volatile—in the last five years we have had four mayors, and five city managers—the city hall is well covered by each of the two daily newspapers, and accordingly we are in a position to receive much publicity. The newspapers have always supported our division, through favorable publicity and through their editorials; the same assistance has been received from the radio and TV stations.

2. *Trucking Companies*

Grand Rapids was one of the first larger cities to institute an internal truck route system and most of our contacts with the many common carriers result from this ordinance. Aware of the importance of the trucking industry to the community, we have had fine cooperation with the Common Carriers Association and with individual truckers themselves.

3. *Parking Lot Operators*

Even with the progress of the Automobile Parking Authority, the private parking operators have made tremendous strides in providing off-street parking in the central business district. The attitude of the parking authority is that whenever possible, private enterprise should solve the parking problem, and therefore the parking lot operators have been most cooperative in dealing with our division. The cooperation received has surprised many visitors to our city who did not think that city officials and the parking lot operators could be on cordial speaking terms.

## Developing Community Good Will

Much good will toward our division has also resulted from the many contacts with local shopping districts, which in this community are fairly well organized, and through the service clubs. One

selling point is the showing of 35 mm. slides taken in the city at locations which are familiar to our citizens and which strongly point out "before and after" conditions. We are continuously taking these photographs and revising our slide file, not only to have a changing talk, but also to be able to show the best examples. Experience shows that people are much more interested in seeing their own community than in having a movie on a general related subject.

We largely work with the local business districts to help them with their parking problem and went so far last year as to actually draw up special assessment districts. Unfortunately, because of a ruling by the city attorney at that time, we did not issue bonds for off-street parking lots, and were not able to proceed. However, our present city attorney indicates that bonds could be issued for this purpose as they could be considered street improvements; and it is hoped that soon our first special assessment districts for off-street parking will be completed.

We have also been able to cement better public relations with the younger drivers in the city by sponsoring a "Hot-Rod" Club to permit the drivers to test their vehicles on an open road without interference; and through the cooperation of the police division, a street was closed for this purpose. Since last year numerous races have been held and it is significant that only *one* of the many boys in the club has received a moving-violation ticket during that time.

Another measure to help sell traffic engineering in Grand Rapids was the policy of enabling the people themselves to determine parking regulations on minor roadways. We found our division was getting considerable adverse publicity for making decisions concerning parking on narrow, residential roadways which, in effect, had little to do with the major movement of vehicles in the city, but which caused much consternation to the city commission and to our own division. Accordingly, after an initial investigation by one of our engineers to determine whether limited or prohibited parking is feasible, pre-stamped post cards are sent to all residents on the block affected and upon the return of these cards proper action is taken.

Two things are accomplished by this method. The first is that residents, not necessarily the property owners, are asked for their advice; and second, if not enough of them are sufficiently interested

to return the cards, we feel we can take any action deemed desirable without undue criticism. Of course, another intangible advantage is that we eliminate the use of petitions which are usually biased because they show only the people who are in favor of the proposal; and, in many cases, people will sign petitions even when they are against the proposal because they are afraid to express themselves honestly when confronted with a neighbor.

Our division also uses portable "No Parking" tripods which are loaned on deposit to contractors and others who need them to prohibit parking in specific locations. Because the use of these tripods is regulated, they are well received; in fact, when the tripods are put out the night before and motorists disregard them, the cars in violation are impounded by the police department. The latter restriction also applies to cars parked in traffic lanes or in spaces where hoods have been placed on meters. Here again, in order to provide service, we will hood meters if in our opinion the request is warranted. To reduce requests, we instituted a service charge of $1.00 per meter per day. We also use different color hoods so that our parking meter servicemen and police officers will know the specific use of the hood.

The major part of our public service operation is answering all inquiries promptly, and preferably by a personal visit to the complainant, if possible. The latter is particularly helpful when attempting to explain that although a suggestion is welcome and warranted, it cannot be readily applied.

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